Research Highlight

on Frontier Materials & Industrial Application

2019

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Foreword

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Alhamdulilah. I am very delighted to present the compilation of all research information related to group of research and research activities under the Frontier Materials and Industrial Application (FMIA) Community of Research (CoRe) Universiti Teknologi MARA (UiTM). All information is compiled into an electronic book (e-book) namely “Research Highlight on Frontier Materials and Industrial Application 2019”.

FMIA is one of the main research priority areas in UiTM. As of June 2019, FMIA consists of 372 researchers and 31 research groups called Entiti kecemerlangan (EK). The total number of EK under the FMIA CoRe is Thirty (30) Research Interest Groups (RIG) and one (1) Research Center (RC). These EK have been established since 2014. All RC and RIG are strategically aligned to the FMIA niche areas (in accordance to the global, national and university priorities), which are Advanced Materials, Industrial Technology, Manufacturing & Automation and Transportation, Mobility & Infrastructure. These research groups comprise of dynamic and enthusiastic researchers who play a vital role in stimulating innovation and encouraging commercialization to produce high quality research outputs within the specified niche areas.

Today in Malaysia, research has become more broadly important than ever before. Hence, there is increasing interest in the emerging of scientific works, particularly the outcomes of the research. Many issues that have become a great concern to Malaysian government and people are related to science and engineering field. Therefore, it is our responsibility as university researchers to give back to the society by acknowledging these concerns and provide necessary solutions to those problems. Often, many do not understand how research is done and how it progresses in our scientific community. Thus, it is now become the obligation of all researchers to make the general public well-informed of their works, expertise and achievement.

Research Highlight on Frontier Materials and Industrial Application 2019 e-book is produced based on the compilation of various research works conducted by active researchers in all research groups under the FMIA CoRe, in which most research works are funded by national, private and/or international industrial grants. This e-book specifically highlights the expertise, strength and achievements of the research groups. It is hoped that this book could serve as a directory of expertise to the academia, external researchers, industrialists and government agencies for future collaborations and new partnerships. FMIA researchers are of critical component in our research culture and environment, and it is hope that the publication of this book will further enhance the visibility of their works.

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Community of Research (CoRe)
Universiti Teknologi MARA

Table of Content

Contents

1.0

Introduction to FMIA

Frontier Materials and Industrial Application (FMIA) is one of the main research priority areas in UiTM. FMIA is managed by the Communities of Research (CoRe) Institute of Research Management and Innovation (IRMI). FMIA is responsible for managing and inculcating research activities at UiTM in the field of materials, technology and industrial application. FMIA consists of 31 Research Interest Group (RIG) and 372 reserchers as of June 2019. The researchers are encouraged to blend their expertise in various field related to functional materials and industry applications. Communication among materials scientists, chemists, physicists, engineers, mathematicians and others in interdisciplinary fields associated with materials and industrial technology are significantly meaningful in order to blossom research and make it a culture in UiTM. This is aligned with the objective of the development of CoRe which is to foster inter-disciplinary and trans-disciplinary collaborations that could transform UiTM's researchers to possess internationally acknowledged research capabilities.

1.1 Area of Interest

All RC and RIG are strategically aligned to the FMIA niche areas (in accordance to the global, national and university priorities), which are Advanced Materials, Industrial Technology, Manufacturing & Automation and Transportation, Mobility & Infrastructure, as shown in Figures 1 and 2. These research groups comprise of dynamic and enthusiastic researchers who play a vital role in stimulating innovation and encouraging commercialization to produce high quality research outputs within the specified niche areas.

Research trust of each research groups may include theoretical, experimental,characterisation, simulation, maintenance, design or fabrication studies of materials and its relation to real industrial applications and sectors. Research on engineering and functional materials in macro-, micro- and nano-scale science are conducted and aligned with advanced technology applied and used in various industries such as automotive, robotics, automation, manufacturing, construction, defense, marine, aviation, agrotechnology, food, sports, textile, oil and gas, chemical and petroleum, dentistry and surgical, processing and packaging, biomaterials and biotechnology, etc. In addition, research on analysis, statistics, economic growth, marketing and management are also important and need to be focused in future.

Research areas of FMIA denominators include Advanced manufacturing, Nanomaterials, Nanostructures, Superconductor, Fracture mechanics, Advanced polymers, Advanced ceramics, Defense materials, Flight technology, Carbon nanotube, Nano-sensors and nano-tracking, Nano pharmaceutical, Nano medicine, Biomedical and Pharmaceutical instrumentation, Automation and robotic, Advanced signal processing, Unmanned aerial vehicle, Automated guided vehicle, Agro-Technology, Industrial electronics, Tribology, Thermofluid and engineering Mechanism, Functional polymers, glasses, ceramics, semiconductors and composites, Electroactive materials, Multi ferroic and magnetic materials, Green and biomaterials, Energy materials, Smart materials, Photonic materials, Graphene and its applications, Rechargeable batteries, supercapacitors, solar cells, sensors, actuators and smart windows, Drug design and delivery, Organic coatings and corrosion, Nano materials, nanoscale architectures and nanodevices, Synthesis and characterization of functional materials, Theoretical modelling/computer simulations of functional materials, Engineering materials and Power sources.

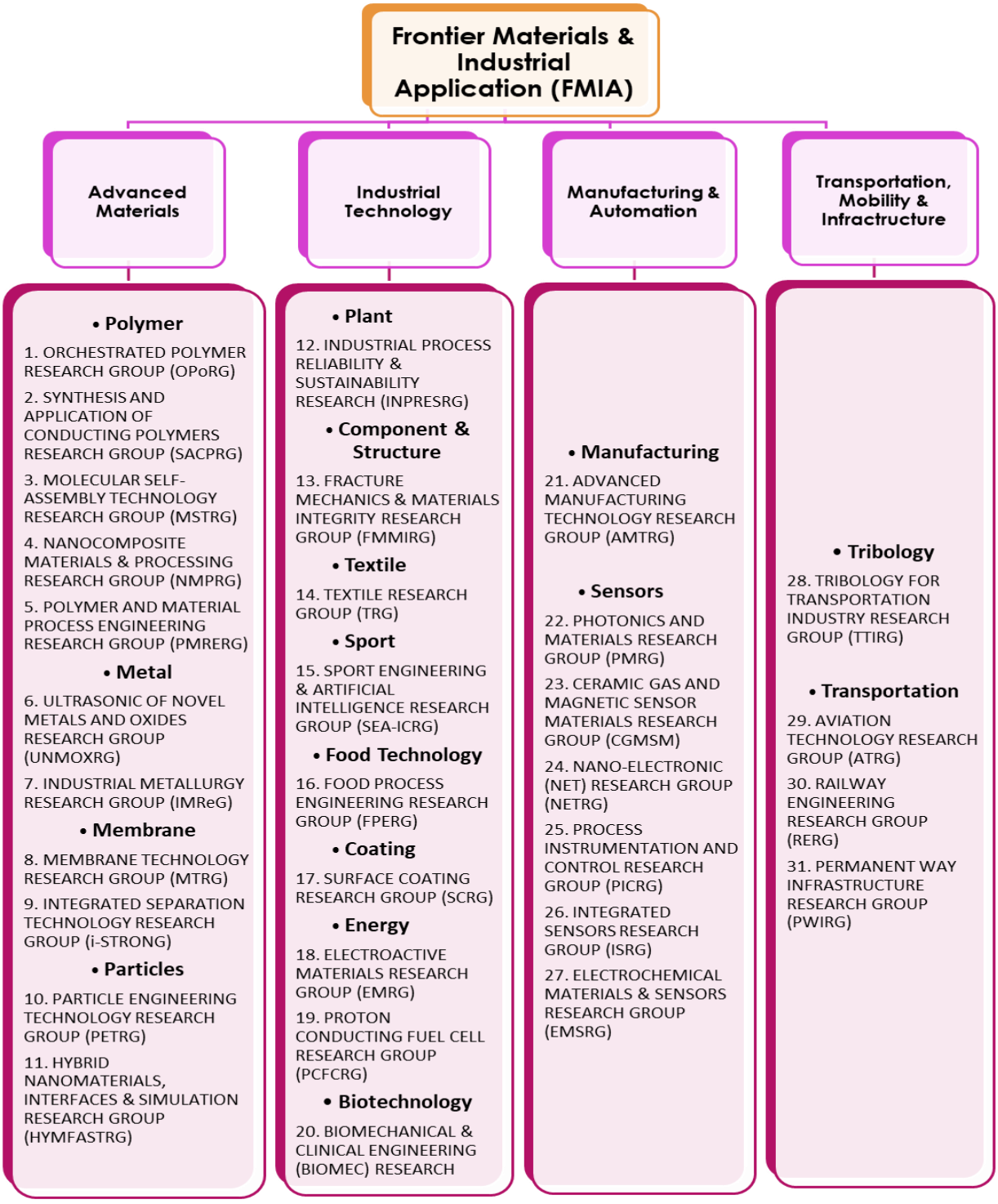


Figure 1: Mapping of FMIA Research clusters and 31 EK research groups

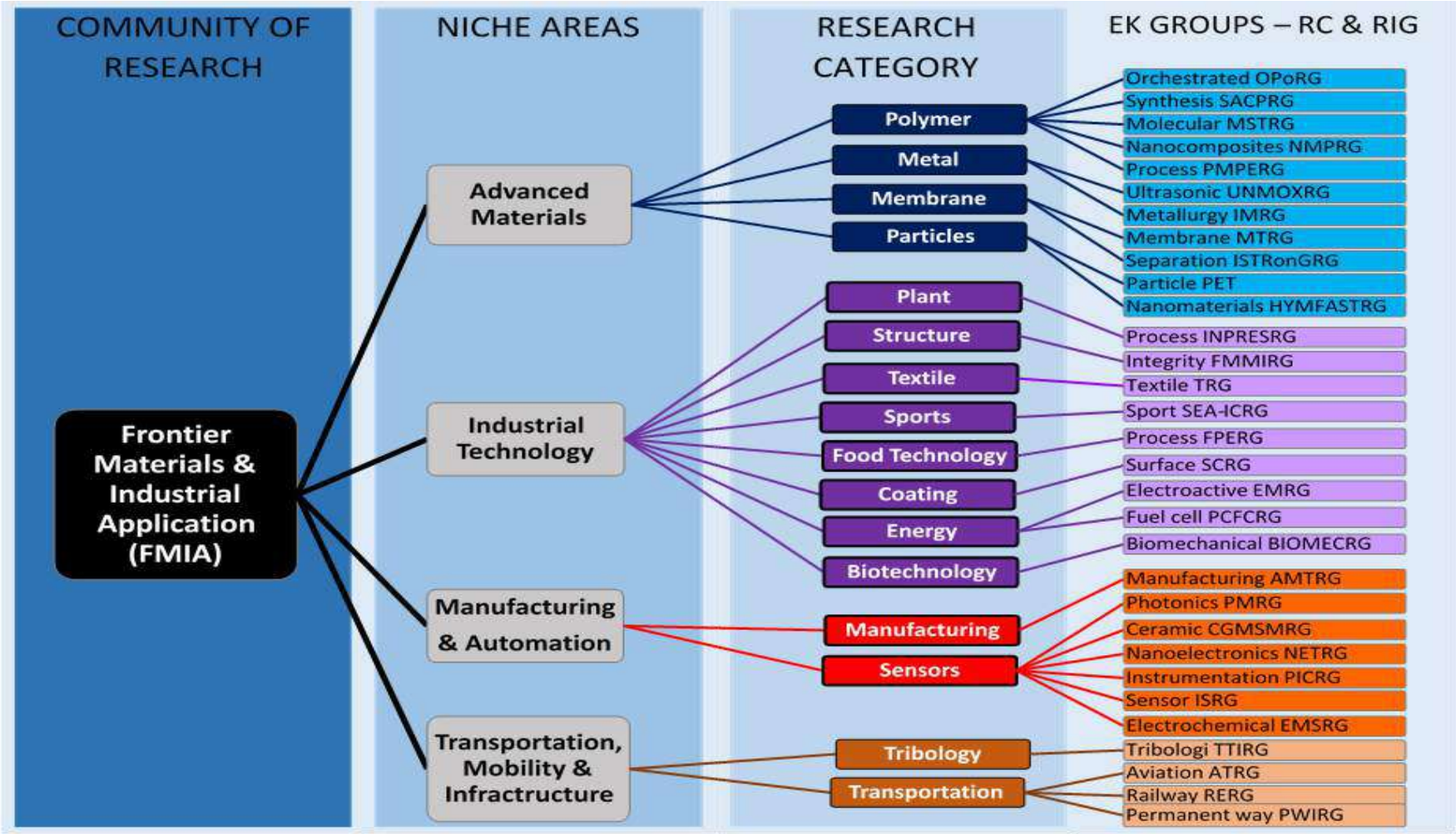


Figure 2: Mapping of FMIA Niche areas, research category and EK research groups

1.2 List of Research Centre (RC) and Research Interest Group (RIG) *Enititi* Kecemerlangan *Tier 4 &5* (EK Tier 4 & 5) FMIA UiTM

NO	EK CODE	EK NAME	TIER	LEADER	MEMBERS	REGISTRATION YEAR
1	CoRe5T4/2019(1)/ FMIA(1)	INDUSTRIAL PROCESS RELIABILITY & SUSTAINABILITY (INPRES)	Tier 4	DR. AZIL BAHARI (FAKULTI KEJURUTERAAN KIMIA-FKK)	1. PROF. DR. KU HALIM (FKK) 2. DR. ALAWI SULAIMAN (F.AGROTEKNOLOGI) 3. DR. ZULKIFLI ABD. RASHID (FKK) 4. DR. NIK RAIKHAN (FKK) 5. DR. NAJMIDDIN YAAKOB (FKK) 6. PROF DR. KHUDZIR BIN ISMAIL(FSG) 7. PN DR. MOHD AZLAN BIN MOHD ISHAK	11 OKTOBER 2017 LULUS SENAT 244 NAIK TARAF KE EK 4 (08 MAC 2019
2	CoRe1/T5/2014/ 1/FMIA/1	PARTICLE ENGINEERING TECHNOLOGY RESEARCH GROUP	TIER 5	PROF. MADYA DR. NOOR FITRAH BINTI ABU BAKAR (FAKULTI KEJURUTERAAN KIMIA-FKK)	1. DR. NORAZAH BINTI ABD RAHMAN (FKK) 2. DR. NORNIZAR BINTI ANUAR (FKK) 3. DR. AHMAD IHSAN BIN MOHD YASSIN (FKE) 4. SYAFIZA BINTI ABD HASHIB (FKK) 5. SITI NORAZIAN BINTI ISMAIL (FKK)	2014
3	CoRe12/T5/2014 /12/FMIA/2	TEXTILE RESEARCH GROUP	TIER 5	PROF. MADYA TS. DR. MOHAMAD FAIZUL YAHYA (FAKULTI SAINS GUNAAN-FSG)	1. DR. NUR'AIN YUSOF (FSG) 2. DR. SUZAINI BT ABDUL GHANI (FSG) 3. DR. AMILY BINTI FIKRY @ AZIZ (FBM) 4. DR. NOR DALILA NOR AFFANDI (FSG) 5. DR. MOHD IQBAL MISNON(FSG) 6. PROF. MADYA DR. MOHD. ROZI AHMAD 7. MUHAMMAD ISMAIL BIN AB KADIR(FSG) 8. DR NOR JULIANA MOHD YUSOF(FSG) 9. DR. RAJA MOHAMMED FIRHAD BIN RAJA AZIDIN(FSSR) 10. ERYNA BINTI NASI(FSG) 11. SURAYA BINTI AHMAD SUHAIMI(FSG)	2014

4	CoRe19/T5/2014 /19/FMIA/4	PHOTONICS AND MATERIALS RESEARCH GROUP	TIER 5	PROF. MADYA DR. MOHD HANAPIAH MOHD YUSOFF (FAKULTI SAINS GUNAAN-FSG)	1. DR. ABDEL BASET MOHAMED EL NABWI ABDEL HAMID IBRAHIM (FSG) 2. SITI NAFISAH BINTI MD RASHID (FSG) 3. DR. IKHWAN NAIM BIN MD NAWI (FSG) 4. DR. ZURIANTI BINTI ABD RAHMAN (FSG) 5. DR. SURAYA BINTI AHMAD KAMIL(FSG) 6. NURKHAIZAN BT ZULKEPLI(FSG) 7. HASNIDA BINTI SAAD(FKE) 8. MAS IZYANI BINTI MD ALIF(FKE) 9. DR HARYANA BINTI MOHD HAIRI (FSG) 10. NOR FARIDAH HANIM BTE MAT JUNIT FSG)	2014
5	CoRe31/T5/2014 /31/FMIA/5	ULTRASONIC OF NOVEL METALS AND OXIDES RESEARCH GROUP (UNMOX)	TIER 5	DR. NORAZILA BINTI IBRAHIM (FAKULTI SAINS GUNAAN-FSG)	1. DR. ROSDIYANA BINTI HASHAM @ HISAM (FSG) 2. DR. ZAKIAH MOHAMED (FSG) 3. SYAFAWATI NADIAH MOHAMED(FSG) 4. PROF. DR. AHMAD KAMAL HAYATI YAHYA(FSG) 5. Ts.DR SHAFINAZ SOBIHANA BINTI SHARIFFUDIN(FKE) 6. PROF. MADYA DR. AHMAD TAUFEK ABDUL RAHMAN(FSG)	2014
6	CoRe33/T5/2014 /33/FMIA/7	CERAMIC GAS AND MAGNETIC SENSOR MATERIALS RESEARCH GROUP (CGMSM)	TIER 5	DR. MISBAH BIN HASSAN (FAKULTI SAINS GUNAAN-FSG)	1. DR. NORAZILA BINTI IBRAHIM (FSG) 2. PROF. MADYA DR. MOHD SALLEH MOHD DENI (FSG) 3. SURAYA BINTI AHMAD KAMIL (FSG) 4. MOHD FAUZI BIN MAULUD (FSG) 5. HAFIZI BIN LUKMAN (FKM)	2014
7	CoRe36/T5/2014 /36/FMIA/8	ELECTROACTIVE MATERIALS RESEARCH GROUP	TIER 5	DR. MOHAMAD FARIZ MOHAMAD TAIB (FAKULTI SAINS GUNAAN-FSG)	1. PM. DR. IR OSKAR HASDINOR BIN HASSAN (FSSR) 2. NAZLI BIN AHMAD AINI (FSG) 3. NOOR `AISYAH BINTI JOHARI (FSG) 4. FAIZATUL FARAH BINTI HATTA (FSG) 5. DR. MUHAMAD KAMIL YAACOB (FSG) 6. DR SITI ZAFIRAH BINTI ZAINAL ABIDIN(FSG) 7. NOR KARTINI BINTI JAAFAR (FSG) 8. DR. ROSNAH ZAKARIA (FSG)	2014

8	CoRe58/T5/2014 /58/FMIA/9	ORCHESTRATED POLYMER RESEARCH GROUP (OPoR)	TIER 5	PROF. MADYA DR. DZARAINI BTE KAMARUN (FAKULTI SAINS GUNAAN-FSG)	1. PM. DR. ROZANA BT MOHD DAHAN (FSG) 2. PM. DR. RAMLAH BT MOHD TAJUDDIN (FKA) 3. DR. ENGKU ZAHARAH BINTI ENGKU ZAWAWI (FSG) 4. DR. HAMIZAH BINTI MOHD ZAKI (FSG) 5. DR. NORAZURA BINTI IBRAHIM (FSG)	2014
9	CoRe68/T5/2015 (3)/FMIA/10	SURFACE COATING RESEARCH GROUP	TIER5	DR. JUNAIDAH BINTI JAI (FAKULTI KEJURUTERAAN KIMIA - FKK)	1. DR. NORLIZA BINTI IBRAHIM (FKK) 2. DR. ISTIKAMAH BINTI SUBUKI (FKK) 3. NOORSUHANA BINTI MOHD YUSOF(FKK) 4. NORASHIKIN BINTI AHMAD ZAMANHURI (FKK) 5. RAFEQAH BINTI RASLAN (FKK) DR. ANIZAH BINTI KALAM (FKM)	2015
10	CoRe80/T5/2015 (15)/FMIA(11)	NANOCOMPOSITE MATERIALS & INDUSTRIAL APPLICATION RESEARCH GROUP	TIER 5	MOHD NAZARUDIN ZAKARIA (FAKULTI SAINS GUNAAN-FSG)	1. PM. DR. SITI NORASMAH BINTI SURIP (FSG) 2. DR. MIMI AZLINA BT ABU BAKAR (FKM) 3. DR. NOOR NAJMI BONNIA (FSG) 4. PROF. MADYA DR. MANSUR AHMAD (FSG)	2015
11	CoRe81/T5/2015 (16)/FMIA(12)	SYNTHESIS AND APPLICATION OF CONDUCTING POLYMERS RESEARCH GROUP	TIER 5	PROF. MADYA DR. TAN WINIE (FAKULTI SAINS GUNAAN-FSG)	1. PM DR. CHAN CHIN HAN (FSG) 2. PM. DR. FAMIZA BINTI ABD LATIF (FSG) 3. DR. TAY CHIA CHAY (FSG) 4. PM. DR. IR OSKAR HASDINOR BIN HASSAN (FSSR) 5. SHARIL FADLI BIN MOHAMAD ZAMRI (FSG) 6. FADIATUL HASINAH BINTI MUHAMMAD (FSG)	2015
12	CoRe89/T5/2015 (24)/ FMIA(13)	NANO-ELECTRONIC (NET) RESEARCH GROUP	TIER 5	DR. MOHAMAD HAFIZ BIN MAMAT (FAKULTI KEJURUTERAAN ELEKTRIK - FKE)	1. DR. AHMAD SABIRIN BIN ZOOLFAKAR (FKE) 2. DR. PUTERI SARAH BINTI MOHAMAD SAAD (FKE) 3. DR. ZURITA BINTI ZULKIFLI (FKE) 4. PUAN NORULHUDA BINTI ABD RASHEID (FKE) 5. Ts DR. PUAN SHAFINAZ SOBIHANA BT. SHARIFFUDIN (FKE) 6. ENCIK UZER BIN MOHD NOOR (FKE) DR. MOHAMAD FARIZ BIN MOHAMAD TAIB (FSG)	2015

13	CoRe90/T5/2015 (25)/ FMIA(14)	PROCESS INSTRUMENTATION AND CONTROL RESEARCH GROUP	TIER 5	PROF. MADYA DR. RAMLI ADNAN (FAKULTI KEJURUTERAAN ELEKTRIK - FKE)	1. PROF. MADYA DR. MOHD HEZRI BIN FAZALUL RAHMAN (FKE) 2. DR NORLELA BINTI ISHAK (FKE) 3. DR. FAZLINA BINTI AHMAT RUSLAN (FKE) 4. DR. PUAN MAZIDAH BINTI TAJJUDIN (FKE) 5. PROF. IR. DR. MUHAMMAD AZMI BIN AYUB (FKM)	2015
14	CoRe91/T5/2015 (26)/ FMIA(15)	AVIATION TECHNOLOGY RESEARCH GROUP	TIER 5	PROF. DR.WAHYU KUNTJORO (FAKULTI KEJURUTERAAN MEKANIKAL - FKM)	1. PROF. DR. WIRACHMAN WISNOE (FKM) 2. DR. BIBI INTAN SURAYA MURAT (FKM) 3. DR. RIZAL EFFENDY BIN MOHD NASIR (FKM) 4. DR. RAMZYZAN BIN RAMLY (FKM) 5. DR. KHAIRUL NIZAM BINTI TAHAR (FSPU) 6. DR. ZURRIATI BINTI MOHD ALI (FKM) 7. DR. NOOR ISWADI BIN ISMAIL (FKM)	2015
15	CoRe98/T5/2016 (3)/FMIA(16)	INTEGRATED SENSORS RESEARCH GROUP	TIER 5	DR. SUKREEN HANA HERMAN (FAKULTI KEJURUTERAAN ELEKTRIK - FKE)	1. DR. WAN FAZLIDA HANIM ABDULLAH (FKE) 2. DR. ZULFAKRI MOHAMAD (FKE) 3. DR. ROSALENA IRMA ALIP (FKE) 4. PROF. MADYA DR. ZAINIHARYATI MOHD ZAIN (FSG) 5. IR. DR. HASHIMAH HASHIM (FKE) 6. PUAN AZNILINDA ZAINODON@ZAINUDDIN (FKE) 7. DR. PUAN ROSMALINI AB KADIR (FKE)	2016
16	CoRe108/T5/2016 (13)/FMIA(17)	FRACTURE MECHANIC & MATERIALS INTEGRITY RESEARCH GROUP (FMMI)	TIER 5	DR. AIDAH BINTI JUMAHAT (FAKULTI KEJURUTERAAN MEKANIKAL-FKM)	1. DR. ZURAIDAH BT SALLEH (FKM) 2. DR. ANIZAH BINTI KALAM (FKM) 3. DR. KOAY MEI HYIE (FKM) 4. DR. NIK ROZLIN BINTI NIK MOHD MASDEK (FKM) 5. MARDZIAH BINTI CHE MURAD (FKM) 6. DR. SHAHRIMAN BIN ZAINAL ABIDIN (FSSR)	2016

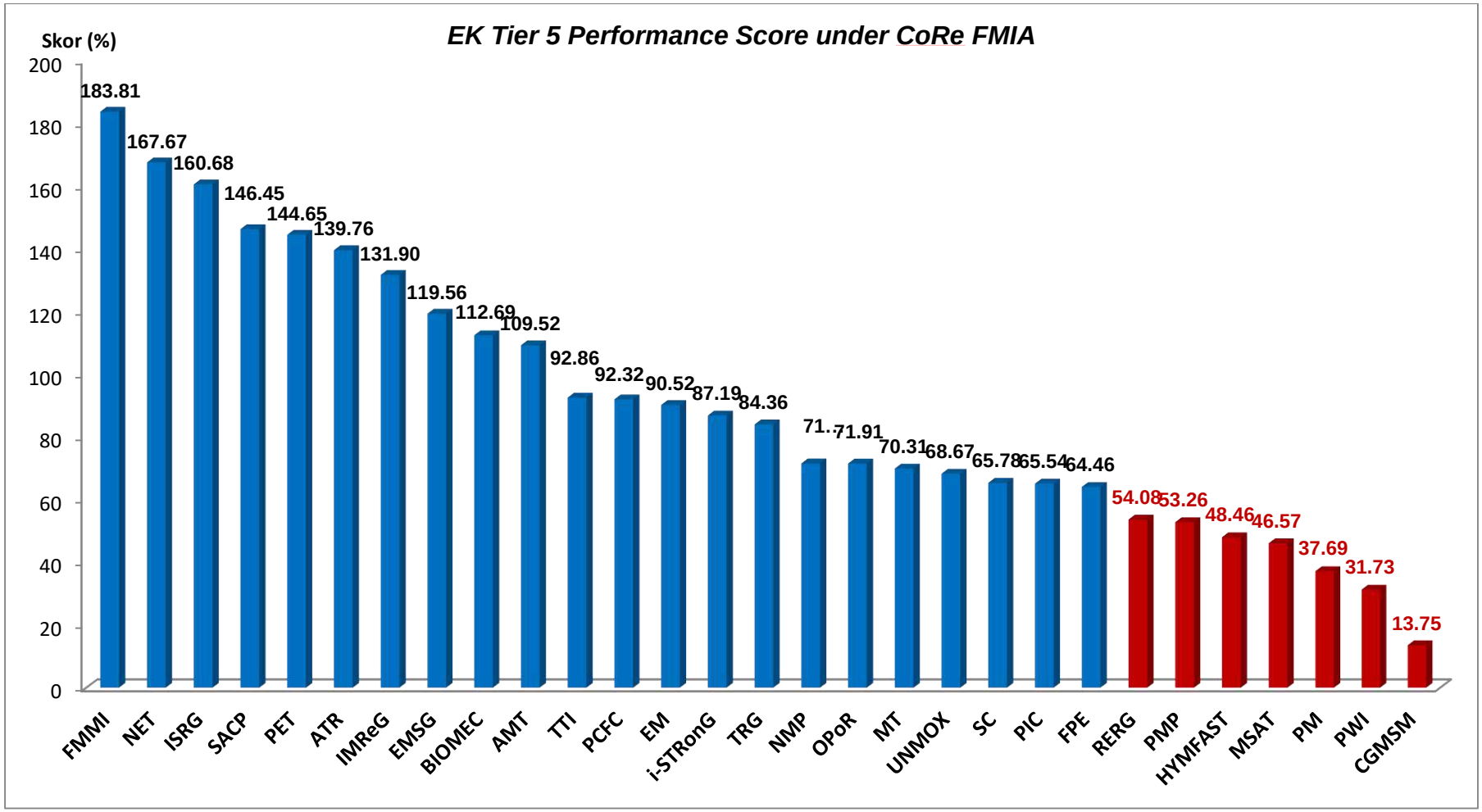
17	CoRe120/T5/2016 (25)/FMIA(18)	ELECTROCHEMICAL MATERIALS & SENSORS RESEARCH GROUP (EMSG)	TIER 5	DR. LIM YING CHIN (FAKULTI SAINS GUNAAN-FSG)	1. PROF. MADYA DR. YUSAIRIE MOHD (FSG) 2. DR. LOW KIM FATT (FSG) 3. DR. IRNI HAMIZA HAMZAH (FKE) 4. PM. DR. WAN FAZLIDA HANIM ABDULLAH (FSG) 5. PROF. MADYA DR. ZAINIHARYATI MOHD ZAIN 6. DR. MOHAMAD NOOR JALIL (FSG)	2016
18	CoRe121/T5/2016 (26)/FMIA(19)	TRIBOLOGY FOR TRANSPORTATION INDUSTRY RESEARCH GROUP	TIER 5	PROF. DR. SALMIAH KASOLANG (FAKULTI KEJURUTERAAN MEKANIKAL-FKM)	1. DR. MOHAMAD ALI AHMAD (FKM) 2. DR. MIMI AZLINA BINTI ABU BAKAR (FKM) 3. DR. NOOR AZLINA BINTI MOHD SALLEH (FKM) 4. DR. MOHD FAIZUL BIN MOHD IDROS (FKE)	2016
19	CoRe125/T5/2016 (30)/FMIA(20)	BIOMECHANICAL & CLINICAL ENGINEERING (BIOMEC) RESEARCH GROUP	TIER 5	PROF. MADYA. IR. DR. JAMALUDDIN MAHMUD (FAKULTI KEJURUTERAAN MEKANIKAL-FKM)	1. DR. SOLEHUDDIN BIN SHUIB (FKM) 2. DR. NOR FAZLI BIN ADULL MANAN (FKM) 3. DR. ABDUL HALIM BIN ABDULLAH (FKM) 4. DR. MOHD AFZAN BIN MOHD ANUAR (FKM) 5. SHAHRUL HISYAM BIN MARWAN (FKM) 6. DR. MUHAMMAD FAIRUZ BIN AZMI (FP)	2016
20	CoRe126/T5/2016 (31)/FMIA(21)	INDUSTRIAL METALLURGY RESEARCH GROUP (IMReG)	TIER 5	PROF MADYA DR. MUHAMMAD HUSSAIN BIN ISMAIL (FAKULTI KEJURUTERAAN MEKANIKAL-FKM)	1. PROF. MADYA NOR 'AINI WAHAB (FKM) 2. IR. DR. BULAN ABDULLAH (FKM) 3. DR. MOHD AZMAN YAHYA (FKM) 4. DR. ISTIKAMAH SUBUKI (FKK) 5. IR. DR. SALINA BUDIN (FKM) 6. DR. SITI KHADIJAH ALIAS (FKM) 7. FAUZIAH YUSOFF (FKM)	2016
21	CoRe127/T5/2016 (32)/FMIA(22)	ADVANCED MANUFACTURING TECHNOLOGY (AMT) RESEARCH GROUP	TIER 5	PROF. MADYA DR. ING. YUPITER HP MANURUNG (FAKULTI KEJURUTERAAN MEKANIKAL-FKM)	1. DR. JURI SAEDON (FKM) 2. DR. WAN EMRI WAN ABDUL RAHMAN (FKM) 3. DR. NOR HAFIEZ MOHAMAD NOR (FKM) 4. DR. MOHD SHAHRIMAN ADENAN (FKM) 5. DR SUHAILA ABD HALIM(FSKM) 6. DR. NOOR AZLINA BINTI MOHD SALLEH 7. DR. ALIAS BIN MOHD SAMAN	2016

22	CoRe144/T5/2017 (4)/FMIA(23)	HYBRID NANOMATERIALS, INTERFACES & SIMULATION (HYMFAST)	TIER 5	DR. NOR AIDA ZUBIR (FAKULTI KEJURUTERAAN KIMIA-FKK)	1. RASYIDAH ALROZI (FKK) 2. DR. AHMAD ZIA UL-SAUFIE MOHAMAS JAPERI (FSKM) 3. DR. ALHAN FARHANAH ABD RAHIM (FKE) 4. DR. ATIKAH KADRI (FKK) 5. DR NORHASLINDA BINTI NASUHA (FKK) 6. HAWAIAH BINTI IMAM MAAROF @ L.MAAROF(FKK) 7. FARAZIEHAN BINTI SENUSI (FKK) 8. DR CHANG SIU HUA (FKK)	2017
23	CoRe147/T5/2017 (7)/FMIA(24)	POLYMER AND MATERIAL PROCESS ENGINEERING	TIER 5	DR. RAHIDA WATI BINTI SHARUDIN (FAKULTI KEJURUTERAAN KIMIA-FKK)	1. CHRISTINA VARGIS JONES (FKK) 2. SUFFIYANA AKHBAR (FKK) 3. ARBANAH MUHAMMAD (FKK) 4. AHMAD RAMLI RASHIDI (FKK) 5. DR. ANA NAJWA MUSTAPA (FKK) 6. DR. SUHAIZA HANIM HANIPAH (FKK) 7. PROF. MADYA DR. RAHMAH MOHAMED (FSG)	2017
24	CoRe155/T5/2018 (4)/FMIA(26)	FOOD PROCESS ENGINEERING RESEARCH GROUP	TIER 5	DR. SITI NOOR SUZILA MAQSOOD UL HAQUE (FAKULTI KEJURUTERAAN KIMIA-FKK)	1. UMMI KALTHUM IBRAHIM(FKK) 2. HABSAH ALWI(FKK) 3. SITI FATMA ABD KARIM(FKK) 4. DR. NOR KHAIZAN ANUAR(FFARMASI)	2018
25	CoRe156/T5/2018 (5)/FMIA(27)	MOLECULAR SELF-ASSEMBLY TECHNOLOGY	TIER 5	DR. NURUL FADHILAH KAMALUL ARIPIN (FAKULTI KEJURUTERAAN KIMIA-FKK)	1. DR. NORNIZAR ANUAR(FKK) 2. DR. SITI NURUL 'AIN YUSOP(FKK) 3. DR. TAN HUEY LING(FKK) 4. SAKINAH MOHD ALAUDDIN(FKK) 5. MUHAMAD FITRI OTHMAN(FKK) 6. HAIRUL AMANI ABDUL HAMID (FSG) 7. DR FARAH HANIM BINTI AB HAMID(FKK)	2018

26	CoRe170/T5/2018 (19)/FMIA(28)	RAILWAY ENGINEERING RESEARCH GROUP (RERG)	TIER 5	IR. DR. RENGA RAO KRISHNAMOORTHY (FAKULTI KEJURUTERAAN AWAM-FKA)	1. AZERAI ALI RAHMAN(FKA) 2. MOHD RAIZAMZAMANI MD ZAIN(FKA) 3. ARUAN EFENDY MOHD GHAZALI(FKA) 4. MOHD JAMALUDIN MD NOOR(FKA) 5. MUHD SALMIZI JAAFAR(FKA) 6. PROF. DR AZMI BIN IBRAHIM(FKA) 7. MUHAMAD AZHAN ANUAR(FKM)	2018
27	CoRe170/T5/2018 (19)/FMIA(28)	MEMBRANE TECHNOLOGY RESEARCH GROUP	TIER 5	DR. NUR HIDAYATI OTHMAN (FAKULTI KEJURUTERAAN KIMIA-FKK)	1. DR. NORIN ZAMIAH KASSIM SHAARI(FKK) 2. DR. LIM YING PEI(FKK) 3. DR. NORHIDAYAH IDERIS(FKK) 4. PROF. MADYA DR. RAMLAH MOHD TAJUDDIN(FKK) 5. MEOR MUHAMMAD HAFIZ SHAH BUDDIN(FKK) 6. ASDARINA YAHYA(FKK)	2018
28	CoRe175/T5/2018 (24)/FMIA (30)	INTEGRATED SEPARATION TECHNOLOGY RESEARCH GROUP (i-STRonG)	TIER 5	DR. FAUZIAH MARPANI (FAKULTI KEJURUTERAAN KIMIA-FKK)	1. DR SITI WAHIDAH BINTI PUASA (FKK) 2. DR ANA NAJWA BINTI MUSTAPA(FKK) 3. DR PUTRI NADZRUL FAIZURA BINTI MEGAT KHAMARUDDIN(FKK) 4. PROF.MADYA DR ZAIBUNNISA BINTI ABDUL HAIYEE (FKK) 5. NUR AIN BINTI MOHD ZAINUDDIN(FKK)	2018
29	CoRe176/T5/2018 (25)/FMIA (31)	PERMANENT WAY INFRASTRUCTURE RESEARCH GROUP (PWI)	TIER 5	MOHD IKMAL FAZLAN BIN ROZLI@ROSLI (FAKULTI KEJURUTERAAN AWAM-FKA)	1. DR KAY DORA BINTI ABD GHANI(FKA) 2. DR NORLIYATI BINTI HAJI MOHD AMIN(FKA) 3. PROF. MADYA DR IR YEE HOOI MIN 4. EN. ANAS BIN IBRAHIM(FKA) 5. EN. JUHAIZAD BIN AHMAD(FKA) 6. PUAN AZURA BT AHMAD(FKA) 7. PUAN NORMARIAH BINTI CHE MAIDEEN (FKM)	2018

30	CoRe177/T5/2018 (26)/FMIA (32)	PROTON CONDUCTING FUEL CELL RESEARCH GROUP	Tier 5	PROF.MADYA DR NAFISAH BT OSMAN (FAKULTI SAINS GUNAAN-FSG)	1. DR NUR HIDAYATI BINTI OTHMAN(FKK) 2. DR ABD MUTALIB BIN MD JANI(FSG) 3. DR ANG LEE SIN(FSG) 4. PN HANANI BINTI YAZID(FSG)	2018
31	CoRe183/T5/ 2019(5)/FMIA(33)	SPORT ENGINEERING & ARTIFICIAL INTELLIGENCE (SEA-I) RESEARCH GROUP	Tier 5	DR. ZULKIFLI BIN MOHAMED (FAKULTI KEJURUTERAAN MEKANIKAL-FKM)	1. EN. MOHD HANIF BIN MOHD RAMLI(FKM) 2. EN. MOHD SAIFUL BAHARI BIN SHAARI(FKM) 3. EN. KHAIRUL IMRAN BIN SAINAN(FKM) 4. DR. RAJA MOHAMMED FIRHAD BIN RAJA AZIDIN(FSSR) 5. DR. HOSNI BIN HASAN(FSSR) 6. EN. MUHAMAD AZHAN BIN ANUAR(FKM) 7. EN. MOHD SAUFY BIN ROHMAD(FKE)	2019

1.3 EK Performance



EK Tier 4 Performance Score: FMIA

BIL.	NAMA EK	AKRONIM	SKOR (%)	PENARAFAN BINTANG
1.	INDUSTRIAL PROCESS RELIABILITY & SUSTAINABILITY (INPRES)	INPRES	★★★★★	115.76

EK Tier 5 Performance Score: FMIA

BIL.	NAMA EK	AKRONIM	SKOR (%)	PENARAFAN BINTANG
1.	FRACTURE MECHANIC & MATERIALS INTEGRITY RESEARCH GROUP (FMMI)	FMMI	★★★★★	183.81
2.	NANO-ELECTRONIC (NET) RESEARCH GROUP	NET	★★★★★	167.67
3.	INTEGRATED SENSORS RESEARCH GROUP	ISRG	★★★★★	160.68
4.	SYNTHESIS AND APPLICATION OF CONDUCTING POLYMERS RESEARCH GROUP	SACP	★★★★★	146.45
5.	PARTICLE ENGINEERING TECHNOLOGY RESEARCH GROUP	PET	★★★★★	144.65
6.	AVIATION TECHNOLOGY RESEARCH GROUP	ATR	★★★★★	139.76
7.	INDUSTRIAL METALLURGY RESEARCH GROUP (IMReG)	IMReG	★★★★★	131.90
8.	ELECTROCHEMICAL MATERIALS & SENSORS RESEARCH GROUP (EMSG)	EMSG	★★★★★	119.56
9.	BIOMECHANICAL & CLINICAL ENGINEERING (BIOMEC) RESEARCH GROUP	BIOMEC	★★★★★	112.69
10.	ADVANCED MANUFACTURING TECHNOLOGY (AMT) RESEARCH GROUP	AMT	★★★★★	109.52
11.	TRIBOLOGY FOR TRANSPORTATION INDUSTRY RESEARCH GROUP	TTI	★★★★★	92.86
12.	PROTON CONDUCTING FUEL CELL RESEARCH GROUP	PCFC	★★★★★	92.32
13.	ELECTROACTIVE MATERIALS RESEARCH GROUP	EM	★★★★★	90.52
14.	INTEGRATED SEPARATION TECHNOLOGY RESEARCH GROUP ((i-STRonG)	i-STRonG	★★★★★	87.19
15.	TEXTILE RESEARCH GROUP	TRG	★★★★★	84.36
16.	NANOCOMPOSITE MATERIALS & PROCESSING RESEARCH GROUP	NMP	★★★★	71.94

17.	ORCHESTRATED POLYMER RESEARCH GROUP (OPoR)	OPoR	★★★★	71.91
18.	MEMBRANE TECHNOLOGY RESEARCH GROUP	MT	★★★★	70.31
19.	ULTRASONIC OF NOVEL METALS AND OXIDES RESEARCH GROUP (UNMOX)	UNMOX	★★★★	68.67
20.	SURFACE COATING RESEARCH GROUP	SC	★★★★	65.78
21.	PROCESS INSTRUMENTATION AND CONTROL RESEARCH GROUP	PIC	★★★★	65.54
22.	FOOD PROCESS ENGINEERING RESEARCH GROUP	FPE	★★★★	64.46
23.	RAILWAY ENGINEERING RESEARCH GROUP (RERG)	RERG	★★★	54.08
24.	POLYMER AND MATERIAL PROCESS ENGINEERING	PMP	★★★	53.26
25.	HYBRID NANOMATERIALS, INTERFACES & SIMULATION (HYMFAST)	HYMFAST	★★★	48.46
26.	MOLECULAR SELF-ASSEMBLY TECHNOLOGY	MSAT	★★★	46.57
27.	PHOTONICS AND MATERIALS RESEARCH GROUP	PM	★★	37.69
28.	PERMANENT WAY INFRASTRUCTURE RESEARCH GROUP (PWI)	PWI	★★	31.73
29.	CERAMIC GAS AND MAGNETIC SENSOR MATERIALS RESEARCH GROUP (CGMSM)	CGMSM	★	13.75

BIL.	ENTITI KECEMERLANGAN			GERAN PI				PENERBITAN					PENYELIAAN	
	NAMA EK	TIER	AHLI	AKTIF		DIPEROLEHI TAHUN 2018		PROSIDING		JURNAL			(BERGRADUAT)	
				BIL	JUMLAH (RM)	BIL	JUMLAH (RM)	INDEKS	TIDAK INDEKS	INDEKS	TIDAK INDEKS	LAIN-LAIN	PhD	MSc
1	FRACTURE MECHANIC & MATERIALS INTEGRITY RESEARCH GROUP (FMMI)	TIER 5	7	20	5,544,140.00	2	4,576,140.00	1	13	28	6	2	3	1
2	NANO-ELECTRONIC (NET) RESEARCH GROUP	TIER 5	8	12	1,422,112.00	2	57,000.00	29	25	28	4	0	1	1
3	INTEGRATED SENSORS RESEARCH GROUP	TIER 5	8	13	1,820,717.16	0	-	5	3	11	4	0	0	4
4	SYNTHESIS AND APPLICATION OF CONDUCTING POLYMERS RESEARCH GROUP	TIER 5	7	13	1,870,630.00	3	787,230.00	3	4	10	1	2	3	0
5	PARTICLE ENGINEERING TECHNOLOGY RESEARCH GROUP	TIER 5	6	12	753,720.00	0	-	10	8	24	10	0	0	1
6	AVIATION TECHNOLOGY RESEARCH GROUP	TIER 5	8	13	583,942.00	2	55,000.00	2	8	35	1	0	0	3
7	INDUSTRIAL METALLURGY RESEARCH GROUP (IMReG)	TIER 5	8	11	806,590.00	1	20,000.00	7	13	22	2	4	0	2
8	ELECTROCHEMICAL MATERIALS & SENSORS RESEARCH GROUP (EMSG)	TIER 5	7	8	1,247,117.16	0	-	0	4	24	2	1	2	4
9	INDUSTRIAL PROCESS RELIABILITY & SUSTAINABILITY (INPRES)	TIER 5	6	11	766,895.00	5	165,000.00	2	5	14	6	0	1	2
10	BIOMECHANICAL & CLINICAL ENGINEERING (BIOMEC) RESEARCH GROUP	TIER 5	7	8	321,000.00	1	25,000.00	2	3	33	3	0	1	3

BIL.	ENTITI KECEMERLANGAN			GERAN PI				PENERBITAN					PENYELIAAN	
	NAMA EK	TIER	AHLI	AKTIF		DIPEROLEHI TAHUN 2018		PROSIDING		JURNAL			(BERGRADUAT)	
				BIL	JUMLAH (RM)	BIL	JUMLAH (RM)	INDEKS	TIDAK INDEKS	INDEKS	TIDAK INDEKS	LAIN-LAIN	PhD	MSc
11	ADVANCED MANUFACTURING TECHNOLOGY (AMT) RESEARCH GROUP	TIER 5	7	12	587,189.66	4	164,435.67	4	10	16	2	2	0	1
12	TRIBOLOGY FOR TRANSPORTATION INDUSTRY RESEARCH GROUP	TIER 5	5	7	248,360.00	3	70,000.00	4	15	12	0	3	0	1
13	PROTON CONDUCTING FUEL CELL RESEARCH GROUP	TIER 5	5	6	558,065.00	0	-	5	8	9	7	0	0	2
14	ELECTROACTIVE MATERIALS RESEARCH GROUP	TIER 5	8	9	1,092,692.00	1	20,000.00	6	5	4	0	0	0	0
15	INTEGRATED SEPARATION TECHNOLOGY RESEARCH GROUP ((i-STRonG)	TIER 5	6	10	391,734.00	2	65,000.00	4	5	7	5	0	0	1
16	TEXTILE RESEARCH GROUP	TIER 5	7	8	466,097.80	2	52,000.00	1	0	10	9	0	1	4
17	NANOCOMPOSITE MATERIALS & PROCESSING RESEARCH GROUP	TIER 5	5	7	187,840.00	3	95,840.00	0	6	5	0	0	2	2
18	ORCHESTRATED POLYMER RESEARCH GROUP (OPoR)	TIER 5	6	7	217,000.00	1	40000.00	7	8	11	2	2	1	0

BIL.	ENTITI KECEMERLANGAN			GERAN PI				PENERBITAN					PENYELIAAN	
	NAMA EK	TIER	AHLI	AKTIF		DIPEROLEHI TAHUN 2018		PROSIDING		JURNAL			(BERGRADUAT)	
				BIL	JUMLAH (RM)	BIL	JUMLAH (RM)	INDEKS	TIDAK INDEKS	INDEKS	TIDAK INDEKS	LAIN-LAIN	PhD	MSc
19	MEMBRANE TECHNOLOGY RESEARCH GROUP	TIER 5	7	8	419,397.00	1	30,000.00	5	6	9	8	0	1	1
20	ULTRASONIC OF NOVEL METALS AND OXIDES RESEARCH GROUP (UNMOX)	TIER 5	7	6	329,700.00	1	30,000.00	0	0	11	0	1	3	0
21	SURFACE COATING RESEARCH GROUP	TIER 5	7	8	364,080.00	1	30,000.00	5	9	7	5	0	0	0
22	PROCESS INSTRUMENTATION AND CONTROL RESEARCH GROUP	TIER 5	6	6	205,000.00	1	32,000.00	2	3	4	0	0	1	3
23	FOOD PROCESS ENGINEERING RESEARCH GROUP	TIER 5	6	7	335,000.00	0	-	1	6	7	5	0	0	0
24	RAILWAY ENGINEERING RESEARCH GROUP (RERG)	TIER 5	8	5	302,500.00	1	30,000.00	10	12	14	1	2	2	0
25	POLYMER AND MATERIAL PROCESS ENGINEERING	TIER 5	8	7	155,000.00	3	75,000.00	1	2	18	10	0	0	2
26	HYBRID NANOMATERIALS, INTERFACES & SIMULATION (HYMFAST)	TIER 5	7	4	394,800.00	0	-	10	11	2	7	0	1	0
27	MOLECULAR SELF-ASSEMBLY TECHNOLOGY	TIER 5	7	5	219,944.40	1	30,000.00	2	8	10	8	0	0	0

BIL.	ENTITI KECEMERLANGAN			GERAN PI				PENERBITAN					PENYELIAAN	
	NAMA EK	TIER	AHLI	AKTIF		DIPEROLEHI TAHUN 2018		PROSIDING		JURNAL			(BERGRADUAT)	
				BIL	JUMLAH (RM)	BIL	JUMLAH (RM)	INDEKS	TIDAK INDEKS	INDEKS	TIDAK INDEKS	LAIN-LAIN	PhD	MSc
28	PHOTONICS AND MATERIALS RESEARCH GROUP	TIER 5	7	5	163,200.00	1	20,000.00	1	5	6	0	0	0	0
29	PERMANENT WAY INFRASTRUCTURE RESEARCH GROUP (PWI)	TIER 5	8	3	218,082.00	0	-	3	18	8	5	4	0	0
30	CERAMIC GAS AND MAGNETIC SENSOR MATERIALS RESEARCH GROUP (CGMSM)	TIER 5	6	1	100200.00	0	0.00	0	0	3	0	0	0	1

2.0

INDUSTRIAL PROCESS RELIABILITY & SUSTAINABILITY (INPRES)

Azil Bahari Alias, Najmiddin Yaakob, Zulkifli Abdul Rashid, Ku Halim Ku Hamid, Nik Raikhan Nik Him, Alawi Sulaiman, Mohd Azlan Mohd Ishak, Khudzir Ismail

2.1 Introduction

Industrial Process Reliability and Sustainability research group is formed to champion research on corrosion engineering, process safety and environmental engineering (solid, water and air) focusing on the industrial applications. Activities emphasize on the following areas:

- Environment: Research on industrial air pollution: Dioxin, Dispersion model (Bayesion Theorem, SPSS, Monte Carlo, ARCGIS), Greenhouse Gases management (CO2, CH4,CFC, N2O, etc), Toxic Gases management (NOX,SOX,etc),and Air Pollution Control Design – (SCRUBBER, CYCLONE. etc.)

- Environment: Research on industrial wastewater treatment (physical, chemical, biological approach), wastewater unit design (primary, secondary, tertiary), and high rate algal ponds (HRAP)-nutrien removal into the biomass potential biofuel production.

- Environment: Research on utilising industrial solid waste (waste to wealth concept) – sludge, biomass, industrial solid waste, MSW etc., developing new material from waste to combat pollution, and industrial solid waste treatment technologies (thermal treatment technologies, composting, landfill).

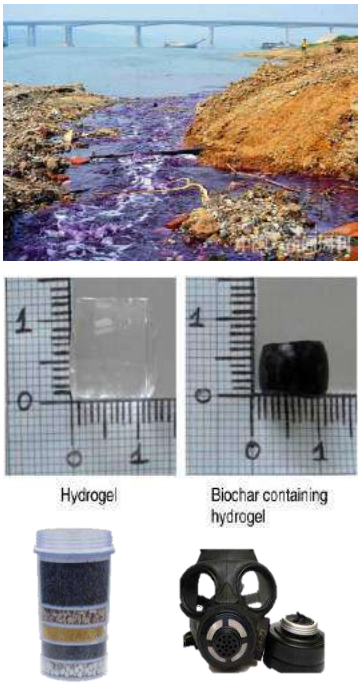
- Process Safety: Research on Consequence Analysis, Facility Siting, Quantitative Risk , Inherent Safety Research and Offshore Safety, Refinery Process Safety.

- Corrosion Engineering: Research on Corrosion Inhibitor Formulation and Testing, Investigation of Corrosion Mechanisms, Corrosion Prediction and Microbial Induced Corrosion.

2.2 Research Highlights

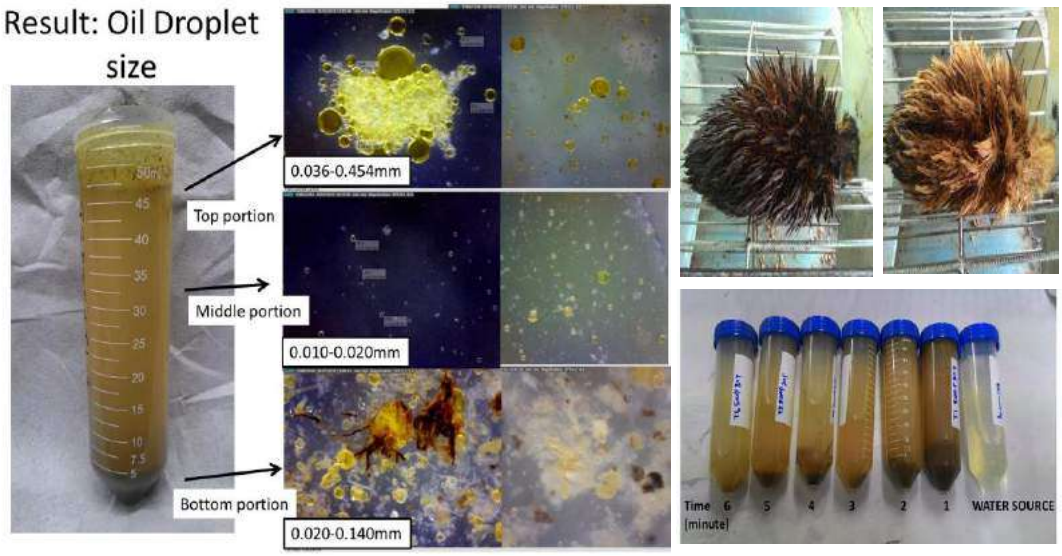
2.2.1 Hydrogel Charsh (HC), a powerful adsorbent

HYDROGEL CHARSH (HC) is a powerful adsorbent to remove unwanted pollutants (gas & liquid forms) and odour. The HC applications are on gas (SO_2, H_2S, and CO_2) and water (heavy metals) filter to combat pollutions and also as a pet litter to tackle odour. HC is originated from combination of polymerize biomass with coal fly ash (waste) as a new improved adsorbent. The research focuses on waste to wealth concept, utilizing waste and adding values to the waste for environmental purposes. HC offers several benefits such as economical viable, high sorption capacity, shorter sorption time, longer lifetime usage and versatile adsorbent. The HC benefits exceeded the current activated carbon (AC) used for the same applications. The HC residues also are very stable and addition of these materials to the soil has the potential to improve soil quality.



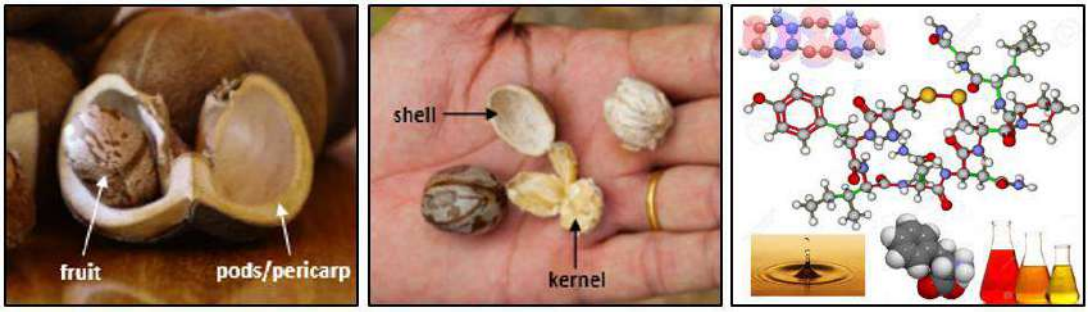
2.2.2 Improvement of Palm Oil Extraction Rate (OER) Through Oil Recovery from Wastes Towards Achieving Zero Waste Strategy

In Malaysia, millions of tons of oil palm biomass are disposed into the environment annually. The oil palm biomass includes oil palm empty fruit bunches (OPEFB), palm oil mill effluent (POME) and oil palm decanter cake (OPDC). Improper disposal of this biomass could lead to soil, water and air pollution. Our study showed that this biomass still contains a small amount of residual oil. After careful investigation, the mechanism of residual oil presence in this biomass was identified and thus possible recommendations to separate the oil from the biomass were made. Interestingly once this biomass was freed from the residual oil, their uses could be enhanced through improved biochemical fermentation process such as in biomethanation and biocompositng. The oil free biomass could also be used for the production of biosugars and biocomposite polymer. The residual oil although could not be used as crude palm oil (CPO), it is still can be used to produce other biochemicals such as biodiesel, biogrease and biolubricant. Towards the end, the final discharge effluent can also be treated and the cleaned water can be used back in the palm oil mill and therefore reducing the environmental impacts of the river water intake and discharge.



2.2.3 Biomass as potential alternative fuels

The IEA's World Energy Outlook reveals that fossil fuels will continue to dominate the energy mix; with 95% of the additional energy demands between 1995 and 2020 will be met by fossil fuels. Therefore, coal will become more important both as an energy source and as the source for organic chemical feedstock in the 21st century. Equally important, biomass is considered to be potential for the renewable energy sources in the future. It already supplies 15% of world's total energy consumption. Biomass is also a source of a large variety of chemicals and materials. Biomass resources that can be used for energy production cover a wide range of materials such as forestry residues, energy crops, organic wastes, agricultural residues, etc. Agricultural waste, readily available biomass, is produced annually worldwide and is vastly under utilized.

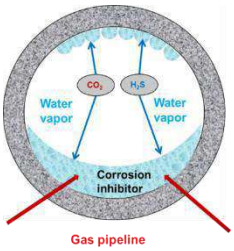


2.2.4 Clay modified- Oil Palm Fruit Bunch (OPFB) Composite

The internal corrosion of pipelines occurs during the transportation of fluids, usually in multiphase form and containing gaseous or liquid hydrocarbons, water or brine, acidic gases such as carbon dioxide (CO_2) and hydrogen sulfide (H_2S), organic acids, bacteria and often entrained solids (sand). The presence of these acidic gases, bacteria and water has the potential to accelerate corrosion in pipelines which are normally made of carbon steel. The mechanism on the corrosion need to be

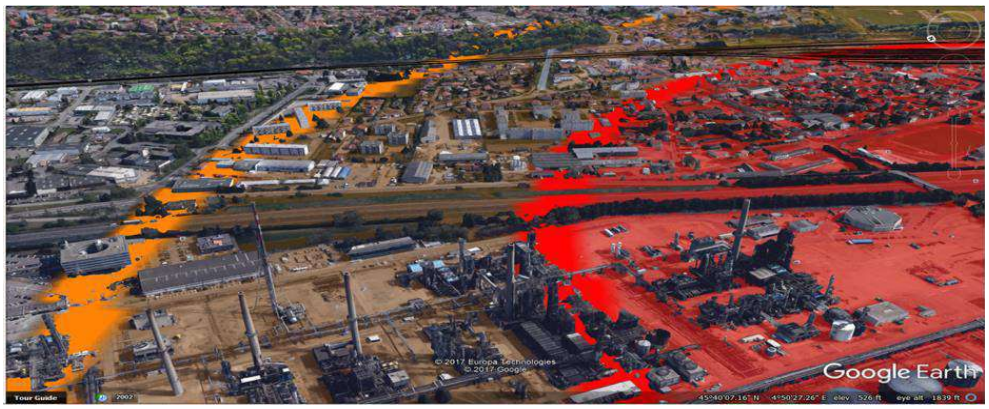
further understood before any mitigation method is proposed. Thus, the researches highlight are:

1) Top of the Line Corrosion in CO_2/H_2S Environments
2) CO_2/H_2S pipeline corrosion mechanism
3) Development of volatile and non-volatile corrosion inhibitor
4) Microbial Induced Corrosion
5) Development of Biocide in Oil and Gas Application



2.2.5 Accident Modeling and Consequences Analysis

Consequence analysis is an evaluation of the predicted outcome from an incident and how it affects the surrounding equipment and people. It is one of the main components of risk assessment and can be used to optimize plant layout, reduce the risk from an unacceptable level by improving design, develop an emergency preparedness plan, and assess the mitigation system. By using consequence models, consequence analysis includes the prediction of the magnitude of potential jet and pool fire, Boiling Liquid Expanding Vapour Explosion (BLEVE), vapour dispersion, toxic chemical release, and explosion caused by incidental release.



2.2.6 Quantitative Risk Assessment

Transportation Risk Analysis for Hazardous Materials Transportation

A numerical procedure, which allows the coupling of time effectiveness and mathematical accuracy, will be developed for the individual risk evaluation, and therefore provides criteria for the route selection of hazardous materials transportation. User-friendly software on transportation risk analysis and the route selection can be developed based on this research. With sufficient data, the incident frequency of different road could be measured given the data of affecting parameters, and then the general models could be built to assess the incident frequency for any kind of road.

Continuous Operational Risk Assessment for a Chemical Process

In this study, the methodology is designed for continuous operational risk assessment. Process variable evolution follows physical/engineering laws, and this evolution is also governed by the performance of the components within the system under assessment. Discrete event simulation is applied to study the stochastic process behaviour of a specific component. Then the process variable evolution directed along discrete event paths is simulated to obtain the real time probability of process variable to exceed safety boundaries.

Uncertainty Delimitation and Reduction for Improved Mishap Probability Prediction

It is important to increase accuracy of the results. Therefore, analysis on uncertainties associated with a QRA is crucial to evaluate the QRA, how close the evaluation is from reality, and how the risk is reliably identified to make good decisions that affect chemical process safety design.

2.2.7 Facility Siting

Facility siting and layout is a process for finding an optimal location for a chemical or petroleum processing site and then arranging the units and equipment. They are

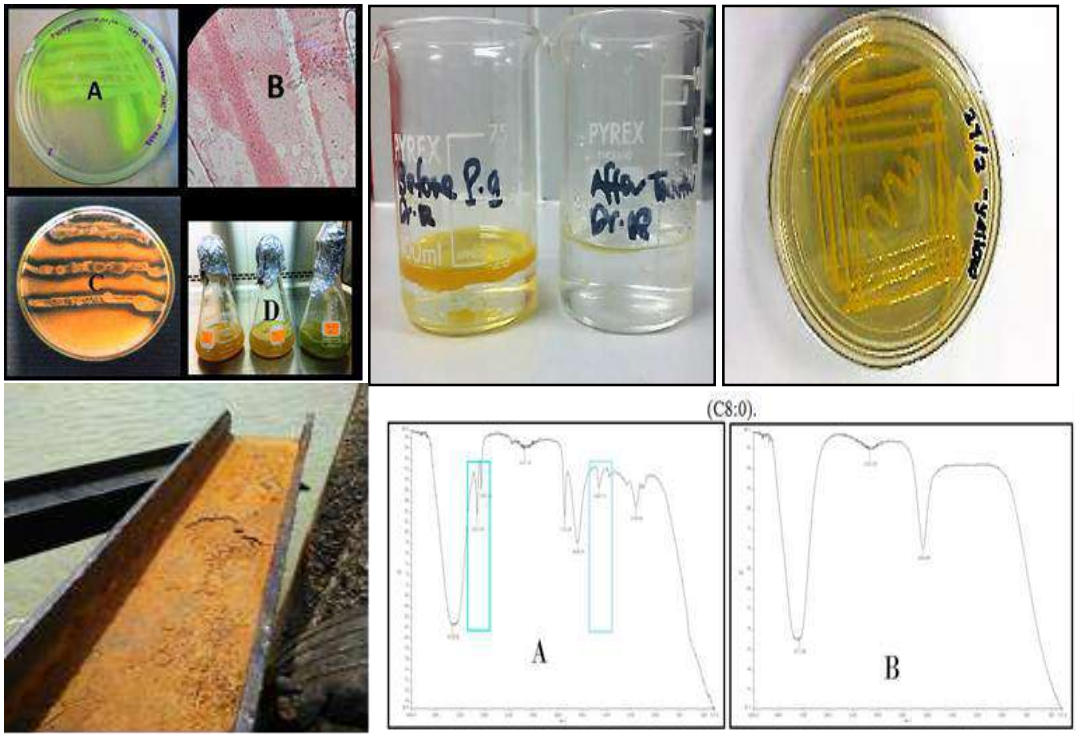
related to how to select a site, how to recognize and assess long-term risks, and how to lay out the facilities and equipment within that site. Appropriate siting and layout establishes a foundation for a safe and secure site. Facility layout optimization based on risk analysis-The purpose of this research is combining optimization concepts and safety concepts in a facility layout. The objective function is the sum of costs for land, piping, managing, protection devices and safety (risk). Based on real meteorological data and various hazardous facilities which have flammable materials, optimal separation distances and directions will be obtained.

2.2.8 Offshore Safety, Refinery Process Safety

Some current and potential process-safety research for offshore applications include facility siting and layout, LOPA/SIS and SIL application in offshore facilities, QRA of offshore facilities (drilling and production), fire protection system (air curtain, water curtain, deluge, expansion foam), fire suppressant agent, and human error assessment.

2.2.9 Application of Microbial of Research in Chemical Engineering (Microbial Engineering)

Microbial engineering based technology has been practiced in my research activities along with other fields such as biotechnology, chemical engineering and alternative fuel development to study the role of microbes into a production of useful products and biorefinery based applications. As an Industrial Microbiologist, I have identified the importance of few industrial microbes such as Pseudomonas aeruginosa, Ochrobactrum anthropic, Pseudomonas luteola, Sphingomonas paucimobilis, Burkholderia cepacia, E.coli, Pseudomonas putida and Pseudomonas fluorescens. For example, the Accelerated Low-Water Corrosion (ALWC) has been confirmed to degrade maritime steel structure in Port Klang, Malaysia and was grouped as one of microbial induced corrosion (MIC) type. This study was performed to isolate, identify, and characterized the growth of the microbes that has induced ALWC in order to decide for the best treatment using understanding of its potential EPS through biofilm formation. Another interesting research is treatment of heavily oiled wastewater using Pseudomonas aeruginosa NR.22 producing usable free fatty acids (FFA) that has been used to produce biodiesel. Apart from this, enzymatic deinking of waste newspapers and laser jet waste paper has been research using fruits and microbes and managed to offer potential opportunities for changing the pulp & paper industry towards more environmentally friendly and efficient operations compared to conventional methods.



2.2.10 Biodiesel

Trans-esterification is a method to convert vegetable oils or animal fats into fatty acid methyl esters. Base catalyst such as sodium or potassium hydroxide and sodium or potassium methoxide are commonly used for trans-esterification. This process is carried out in batch mode, time consuming and requires several steps of processing units. In fact, such technology needs high investment and no longer competitive especially when the global oil price is low. Thus, new technology is required to overcome the problem and to cater low grade of feed stocks. With the believe that in case of methyl ester production, the role of catalyst can be replaced and enhancement of molecular collision can be done differently, ultrasonic wave and high speed mixing were exploited to transpire the NON CATALYTIC REACTION FOR METHYL ESTER PRODUCTION. Ultrasonic waves are longitudinal mechanical waves which generate cavitation bubbles as they transmit through a liquid medium. In chemical reaction, the progress of the reaction depends heavily on how quickly the reactants are brought together. For the reaction to occur, the pure reactants need to be homogenized at the molecular scale so that molecules can collide. If the mixing is fast enough, the intrinsic chemical kinetics governs the rate of production of new species. Based on this understanding, high speed mixing was introduced to enhance successful molecular collision of methyl ester reactants after gaining energy from ultra-sonic device. We have a very strong believe that most of catalytic chemical reactions nowadays can be replaced by using this technique. Probably, it is a breakthrough in chemical reaction engineering and inspires the green technology.



2.3 Group Information and Background of Members

Name of RIG	Industrial Process Reliability & Sustainability (INPRES)
Leader	Dr. Azil Bahari Alias
Tier	4
RIG Code	CoRe5T4/2019(1)/FMIA(1)
Registration Year (Senate Approval)	2017 NAIK TARAF KE EK 4 (08 MAC 2019)
UiTM Niche Area	Chemical & Advanced Materials
RIG Niche Area	Reliability and Sustainability Engineering Research on corrosion engineering, process safety and

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Energy, Environment & Process Safety
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Universiti Sains Malaysia
MSc (Industrial Microbiology & Enzyme Production
Universiti Sains Malaysia
B.Eng Hons (Industrial Microbiology)
Universiti Sains Malaysia

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3.0

PARTICLE ENGINEERING TECHNOLOGY (PET) RESEARCH

Noor Fitrah Abu Bakar, Norazah Abd Rahman, Nornizar Anuar, Siti Norazian Ismail, Syafiza Abd Hashib, Ahmad Ihsan Mohd Yassin

3.1 Introduction

PET research group fosters research on applying particle engineering technologies including electric-force assisted techniques, microwave assisted techniques, crystallization, drying and gasification for production of material and nanomaterial for pharmaceutical, energy, food, oil and gas applications.

Research activities emphasize on the following areas:

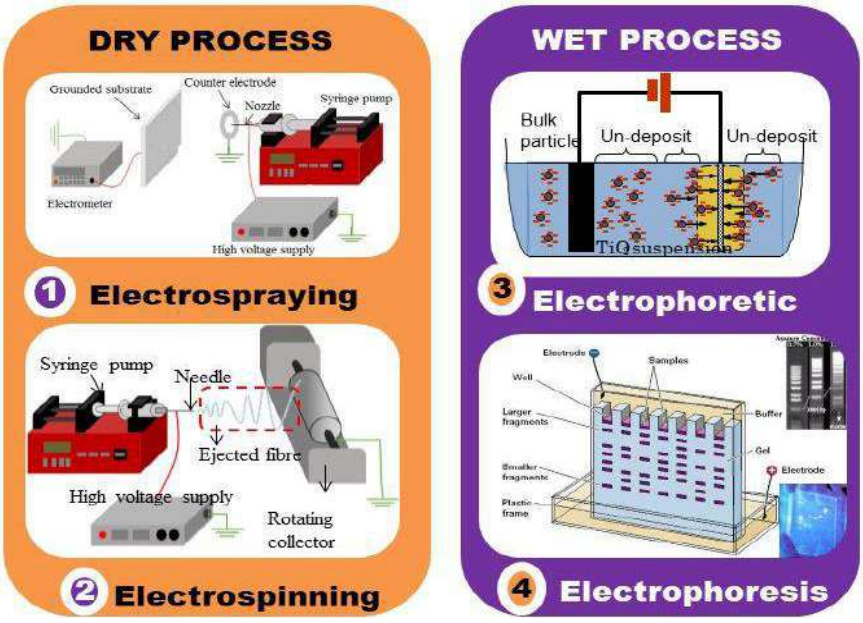
1. Development of latest and advanced techniques and processes for synthesizing and characterizing of material and nanomaterial based on experimental, mathematical modeling and simulation
2. Development of new materials including advanced specialty chemicals and biomaterial for pharmaceutical, energy, food, oil and gas application
3. Knowledge and technology transfer to industrial partners including chemical design, improvement of processes for clean and optimized production

The group members are actively involved in supervising post graduate students and collaborating research activities at international level including Japan, United Kingdom, Tunisie and recently China. The postgraduate students undergone outbound and inbound research attachment at those countries.

3.2 Research Highlights

3.2.1 Electric Force Assisted Technique for Synthesizing Nanomaterials

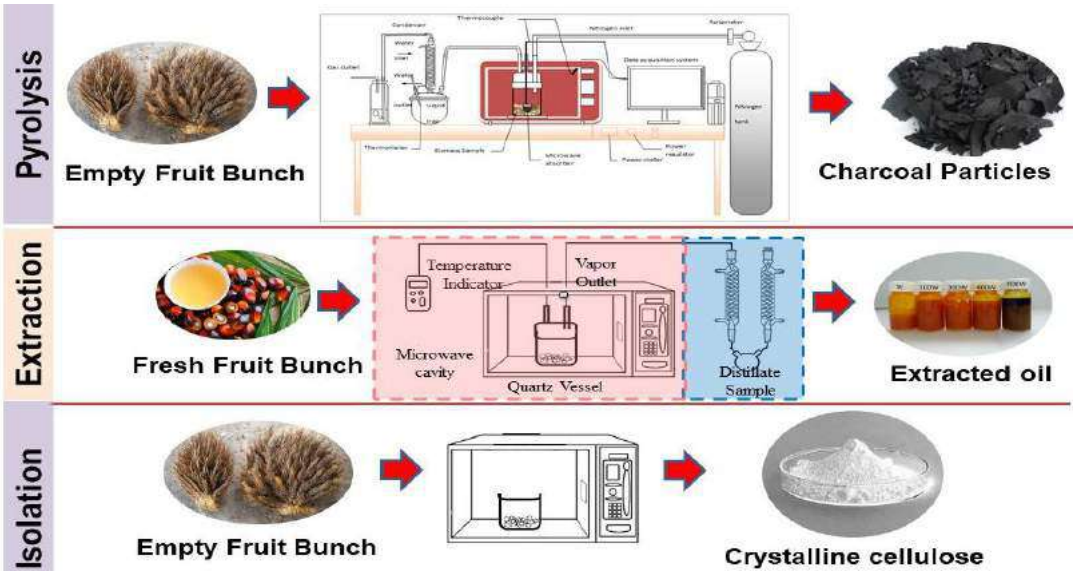
Electric force assisted techniques are introduced for designing and producing nanomaterials in a form of nanoparticles, nanofibers and nanoemulsions via electrospraying, electrospinning and ultrasonication, respectively. The electrospraying technique can be applied for any materials that are suspended in solution by referring to the surface charge (zeta potential values). Electrospinning technique can be applied on polymeric material for producing nanofiber that can be applied for coating and forming nanocomposite for immobilization of biomaterial such as enzyme and antibiotic. Emulsified nanoemulsion produced oil droplet with surface charge that can be separated using electrophoresis according to the applied voltage. This technique can be applied for separating bioactive compounds in the emulsified oil. The electric force assisted technique such as electrophoretic deposition (EPD) can be applied for depositing nanomaterials on any conductive surface in a wet condition. This technique has been applied for removing iron oxide fine particles in tap water.



3.2.2 Material Processing via Microwave Assisted Technology

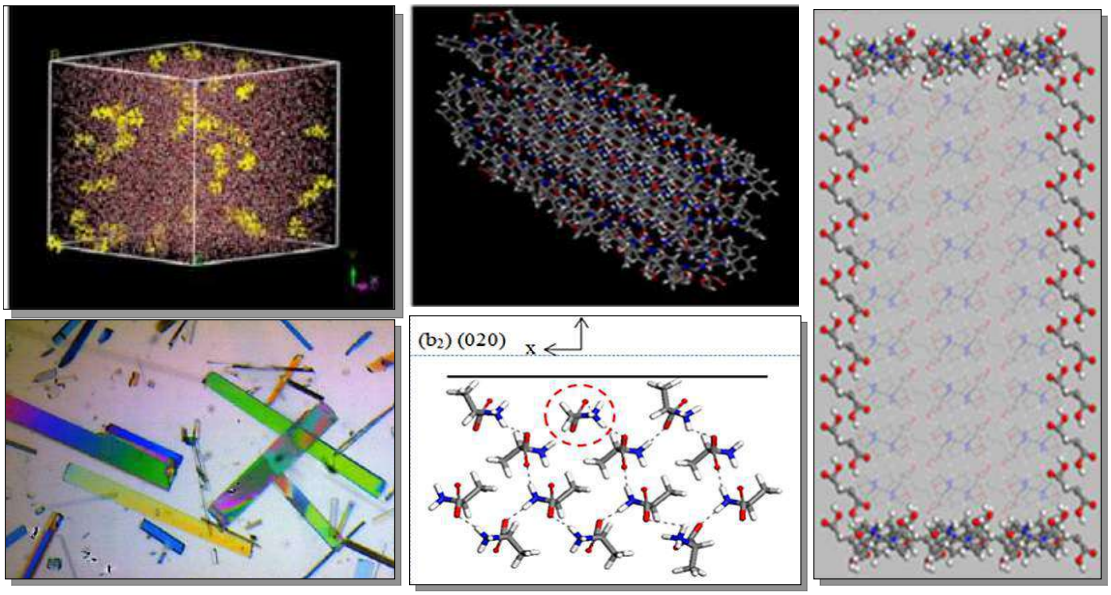
Microwave (MW) assisted technology is an effective technique that manipulates the dielectric properties of materials to shorten the heating duration. This technique is suitable for thermochemical conversion process namely pyrolysis and torrefaction; oil extraction process, and isolation of cellulose from palm oil fruit bunches. The solid char particles derived from microwave assisted pyrolysis of oil palm biomass can be produced. Sterilization of oil palm fruit and extraction of palm oil can also be conducted via MW assisted technique with small addition of water in comparison to traditional sterilisation technique which consumes enormous amount of water in a form of steam. The MW assisted technique is also applicable in assisting the isolation

of cellulose from any cellulosic material. The time required for heating process is reduced as compared to conventional heating technique.



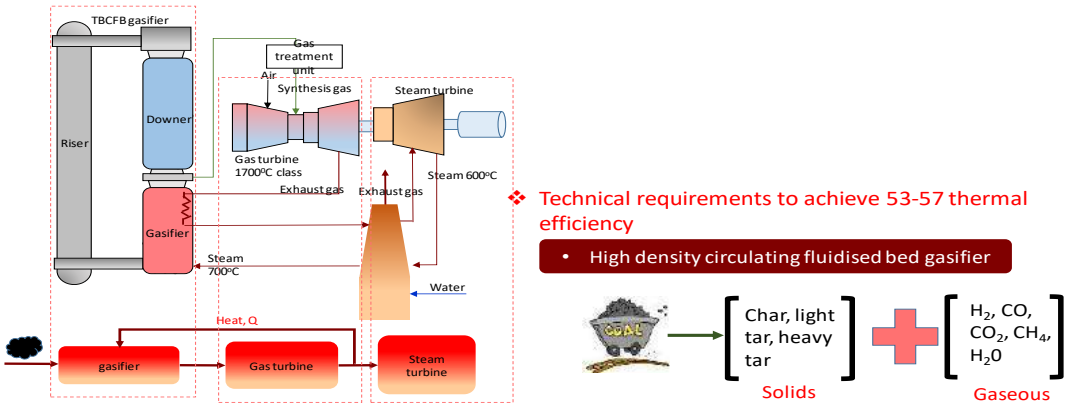
3.2.3 Crystals Behaviour Prediction using Molecular Modelling Technique

Molecular modelling technique is used to predict the behaviour of molecular interactions between solute and solution prior to nucleation, between molecules and atoms within crystals and between clustering solutes in solution. The most recent work is the prediction of dissolubilisation behaviour of crystals in solution. Detail calculation on the hydrogen bonds interactions of the molecules enables prediction of foreign molecules (eg: solvents or impurities molecules) inclusions to the crystal structures. It also explains the most unstable sites of the crystals, and hence allows shape modification, to ease materials downstream processing. Calculation of the most stable energy, as a summation of hydrogen bond, van der Waals and electrostatic force validates the observations of the molecular interactions carried out.



3.2.4 Advanced-Integrated Gasification Combined Cycle (A-IGCC)

Advanced-Integrated Gasification Combined Cycle (A-IGCC) is a system developed using coal to overcome the technical limitation in IGCC system in order to obtain higher plant efficiency. Triple bed circulation fluidised bed operated at 700-900^{o}C is used in the system while steam is used as gasifying agent instead of oxygen. In this system, the endothermic heat for downer pyrolysis and gasification is supplied using gas turbine and riser.

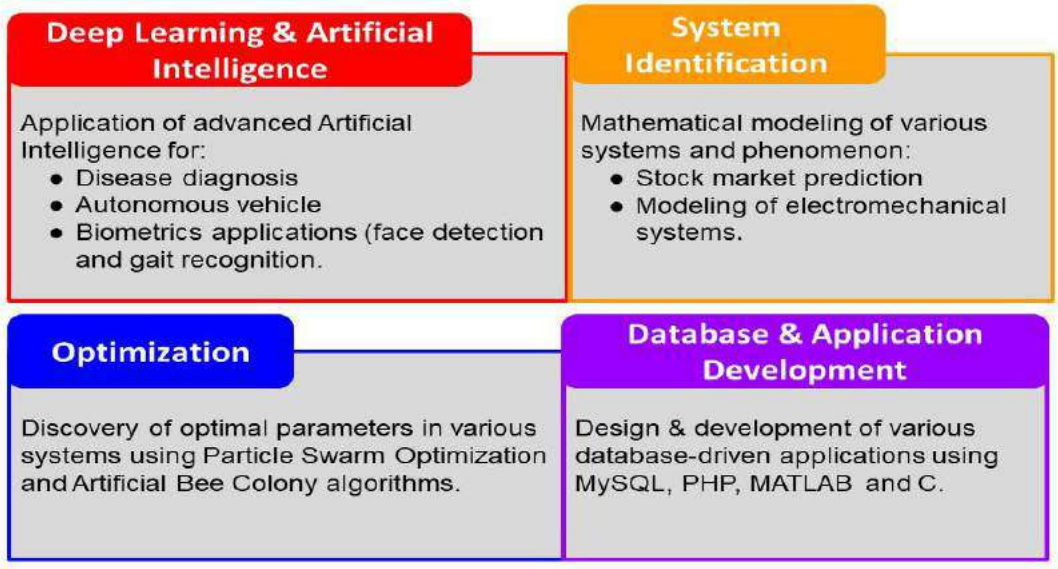


3.2.5 Spray Drying of Ananas Comosus using Centella Asiatica as Encapsulation Matrix

Spray drying provides a hygienic handling of the powders while retaining the nutrients and enzymes of the fruit. However, the conventional encapsulation through spray drying could degrade Ananas Comosus nutritional properties due to high temperature application and extensive energy usage. Furthermore, in conventional encapsulation process, the amount of food additives (Maltodextrin) usage is quite extensive. This work is proposed in order to investigate the capabilities of spray dryer in Ananas Comosus encapsulation and minimizing the amount of Maltodextrin and substitution with Centella Asiatica as encapsulation matrix. This proposed study will combine the encapsulation inlet temperature and substitution of Maltodextrin with Centella Asiatica, which should be able to reduce the amount of extensive energy usage and retaining Ananas Comosus nutritional properties.

3.2.6 Advanced Computational Simulation and Modeling

Computer sciences can be applied in various sectors in life. Advanced artificial intelligence for example can be applied in disease diagnosis, autonomous vehicle and biometrics applications (i.e face detection and gait recognition. Mathematical modelling of various systems and phenomenon can be used to predict the stock market and predict electromechanical systems. Optimization of a system also can be achieved through the application of computer sciences. For example, the application of Particle Swarm Optimization and Artificial Bee Colony algorithms is used to find the optimal parameters in various systems. Various software builds with specific algorithms (i.e MySQL, PHP, MATLAB and C) also helps in design and development of database.



3.3 Group Information and Background of Members

Name of RIG	Particle Engineering Technology
Leader	Assoc. Prof. Dr. Noor Fitrah Abu Bakar
Tier	5
RIG Code	CoRe1/T5/2014/1/FMIA/1
Registration Year (Senate Approval)	2014
UiTM Niche Area	Chemical & Advanced Materials
RIG Niche Area	Research on applying particle engineering technologies including electric-force assisted techniques, microwave assisted techniques, crystallization, drying and gasification for production of material and nanomaterial for pharmaceutical, energy, food, oil and gas applications

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BACKGROUND

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NICHE AREA: Crystallization

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BACKGROUND

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- BEng. (Hons), Universiti Teknologi Malaysia (UTM)

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NICHE AREA: Drying Technology

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BACKGROUND

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- MSc., Universiti Teknologi MARA, Malaysia
- BSc. Electrical Engineering (Information Systems) Universiti Tun Hussein Onn, Malaysia

NICHE AREA: Advanced Computation, Electrical Engineering

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4.0

TEXTILE RESEARCH GROUP (Textile TRG)

Mohamad Faizul Yahya, Mohd Rozi Ahmad, Amily Fikri Aziz, Suzaini Abd Ghani, Nur'ain Yusof, Nor Dalila Nor Affandi,Mohd Iqbal Misnon, Muhammad Ismail Ab Kadir, Nor Juliana Mohd Yusof, Raja Mohammed Firhad Raja Azidin,Eryna Nasi and Suraya Ahmad Suhaimi

4.1 Introduction

The objective of the Textile TRG is to serve as a centre for research and advancement in Technical Textiles and Smart Apparel.

Research themes:

- Smart Textiles
- Simulation and Modelling of Textiles
- Textile & Clothing Comfort Studies
- Nanofibres via Electrospinning
- Songket Mechanization
- Natural Dyes Extraction & Coloration

Services and Activities:

- Testing services
- Consultations
- Short courses / Seminars
- Research projects
- Industrial collaborations

4.2 Research Highlights

4.2.1 Songket Structures with Jacquard Technology

The project revolves on utilizing Jacquard technology to produce songket fabrics and motif using mechanical loom. With this technique, production of songket can be increased tremendously with very consistent fabric quality. The production rate of songket making using Jacquard technology is extremely high (if a local hand weaver takes a minimum of one week to produce a piece of songket, Jacquard weaving technology takes only 20 minutes). The songket produced is suitable for use such as uniforms, special events such as convocations, and for the hotel industry as interior decorations and so on. In summary, among the advantages of producing songket using the Jacquard technology are as follows:

- High quality songket and free from defects
- Able to use multiple types of yarns and colors
- Able to produce different colors on both sides of the songket fabric
- The songket can be used on both surfaces (double-face)

- The songket has flat surfaces and no issues with floating threads

After a few years of research efforts, the researchers signed a MOU with a local textile company, Ara-Borgstena Sdn Bhd on 28 April 2010. The company agrees to produce, market and commercialized songket fabrics and products using Jacquard technology through transfer of technology and licensing. The MOU was renewed in 2016. The company has been paying annual licensing fees to UiTM as well as royalties from the sales they make since 2011. The innovation was among the finalist for Anugerah Inovasi Negara 2017 (AIN2017), a yearly event organised by the Ministry of Science, Technology & Innovation.

4.2.2 Electromagnetic Shielding Fabrics

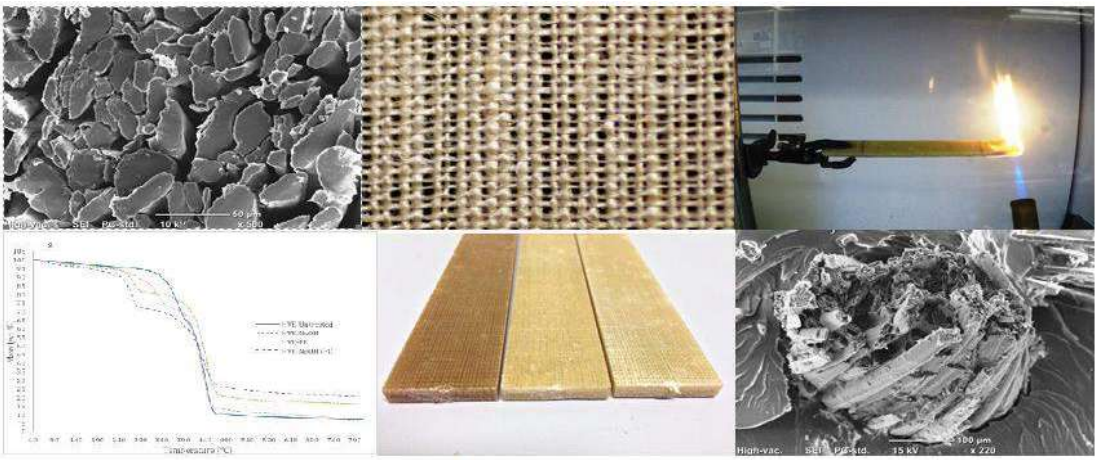
Electromagnetic (EM) shielding tests are conducted in plane state, however, upon forced deformation of textile shields, the warp and weft yarns tends to slip away perpendicular to the direction of force and hence causes enlarged interstices. Since the electromagnetic waves can pass though the openness in the shields without attenuation of power, therefore the effectiveness of these textile EM shields declines. The study utilizes hybrid yarns which locks the adjacent warp and weft yarns in between the spiral of the metallic filament. The increase in cell size, upon forced deformation during puncture testing, was reduced 4.5 times in the proposed (self-locking) fabrics as compared to the conventional fabric. This self-locking behaviour of hybrid yarn is not only responsible for stability of interstices, but also resists during yarn pull-out from the fabrics. The electromagnetic shielding effectiveness of the proposed design could attenuate 99.9% power at 3 GHz threshold frequency.

4.2.3 Natural dyes extraction from Seaweeds

The research currently focuses on the extraction of natural dye from green seaweed of *Caulerpa lentillifera* as textile colourant. The seaweeds were extracted using boiling water and ammonia fermentation methods. The dyeing was then performed by exhaustion at 85°C for 60 min. Three types of mordant were used by metachrome or simultaneous addition of mordant and dye in the dyebath. The dyed samples were measured using spectrophotometer to analyse the shades obtained with regards to L*a*b* values and K/S values. The dyed samples were also compared in terms of their ability to withstand washing, perspiration, rubbing/crocking and light. The results have shown that the natural dye obtained from boiling water extraction method gave higher K/S values in comparison with the dye obtained from ammonia fermentation method. Fastness properties of the dyed samples were evaluated according to MS ISO standard and ranged from good to excellent rating except for lightfastness which is poor. The research is currently in progress for other types of extraction techniques.

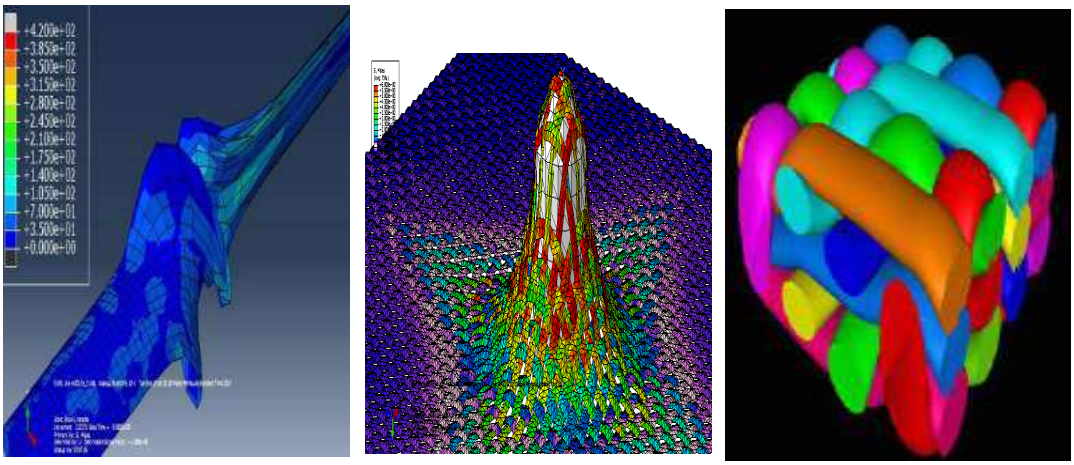
4.2.4 Natural Fibres Reinforced Composites

Traditional building materials are progressively being replaced by natural fibre reinforced composites (NFRC) due to its advantages and some big environmental issues such as congested landfill and over logging activities. Nevertheless, its degradability due to several factors such as fire, moisture and weather (sunlight) could stops its popularity. The knowledge on the NFRP degradation rates is important to be obtained for the sake of consumers' safety issues. Therefore, this research investigates the degradation factors such as fire retardancy, water absorptions, weather etc. on several types of NFRC's (e.g. jute, hemp, ramie etc) properties. This research will open rooms for composite quality improvement and new applications in construction industry.



4.2.5 Geometric Model Research

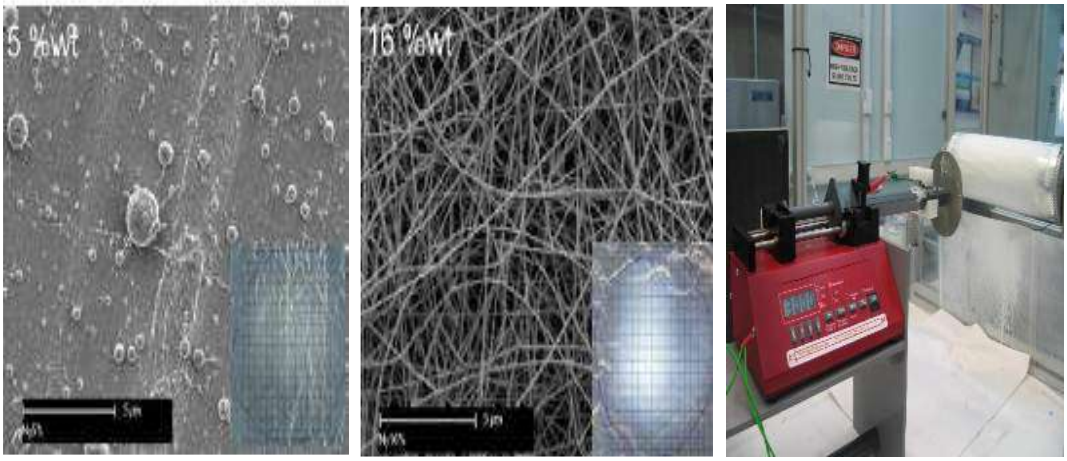
The research focuses on the development and application of quantitative methods for solving textile engineering problems. The group attempts to understand, analyze and predict complex textile mechanical and thermal responses by using numerical analysis methods such as Finite Element Analysis (FEA) and Structural Equation Modeling (SEM). Woven fabric geometry are developed with FEA preprocessor for multitude numerical analysis procedures of tensile and impact modeling, at various material properties. The simulated models are compared with experimental for validation. Future work is expected in composites modeling. Further work in Structural Equation Modeling involved in measuring thermal management and objective evaluation of woven fabric. The study gives a better understanding on human reaction to thermal and moisture management properties based on first touch experience and compared to measurement using standard equipment



4.2.6 Electrospun Nanofibre Research

Electrospinning has gained a great deal of attention due to its versatile and simple technique to fabricate polymeric nanofibres in long and continuous fibre form. A random accumulation of the nanofibres forms an electrospun membrane which exhibits high porosity and surface area as well as light weight. Due to these

outstanding properties, the Textile Research Group has carried out a number of research studies particularly on the formation and characterization of electrospun nanofibres made from synthetic and biodegradable polymers. The study investigates the effects of electrospinning parameters such as applied voltage, nozzle tip-to-collector distance and flow rate on the morphological structures of electrospun nanofibres. A combination of the parameter produces different structures such as cylindrical, beaded, ribbon-like fibre as well as nano and microbeads. The resultant fibre diameter is in a range of 50nm to 1000nm. The research group also studied the feasibility to incorporate functional materials such as zeolite and titanium dioxide (TiO_2) in order to enhance the properties of nanofibre composites. Another area of study is to employ electrospun nanofibre membranes as filter media. The membrane has been tested for remediation of pigment from textile wastewater. Future direction of the study is to identify potential application of the fibres that leads to the commercialization of nanofibre product produced by electrospinning process.



4.3 Group Information and Background of Members

Name of RIG	Textile Research Group (TRG)
Leader	Prof. Madya Ts. Dr. Mohamad Faizul Yahya
Tier	5
RIG Code	CoRe12/T5/2014/12/FMIA/2
Registration Year (Senate Approval)	2014
UiTM Niche Area	Textile Science & Technology
RIG Niche Area	Smart Textiles, Simulation and Modelling of Textiles, Textile & Clothing Comfort Studies, Nanofibres via Electrospinning, Songket Mechanization, Natural Dyes Extraction & Coloration

Assoc. Prof. Dr. Mohd Rozi Ahmad
Faculty of Applied Sciences

Expertise: Textile Mechanics and Natural Dyes

Dr. Suzaini Abd Ghani
Faculty of Applied Sciences

Expertise: Textile Evaluation

Dr. Mohamad Faizul Yahya
Faculty of Applied Sciences

Expertise: Textile Mechanics and Modelling

Dr. Amily Fikri Aziz
Faculty of Business and Management

Expertise: Consumer Behaviour

Dr. Nur'Ain Yusof
Faculty of Applied Sciences

Expertise: Clothing Science

Dr. Nor Dalila Nor Affandi
Faculty of Applied Sciences

Expertise: Fibre Science, Nanofibre Formation

Dr. Mohd Iqbal Misnon
Faculty of Applied Sciences

Expertise: Textile Composites

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2. N Talib, MR Ahmad, K Ismail, MI Ab Kadir, “Comparison of Supercritical Fluid Extraction and Ultrasound-assisted Extraction of Natural Dyes from a Brown Seaweed (Sargassum spinosum)”, International Journal of Textile Science 5 (6), 141-144, 2016
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6. MI Misnon, MM Islam, JA Epaarachchi, KT Lau, “Analyses of woven hemp fabric characteristics for composite reinforcement”, 2015

5.0

ELECTROACTIVE MATERIALS RESEARCH

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5.1 Introduction

Electroactive Materials research group is formed to promote the development of synthesis, characterization and computational investigations of advanced materials for energy applications.

Many activities emphasize on the following areas:

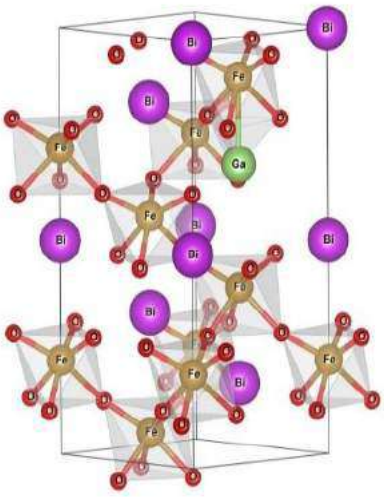
1. Design and analysis of advanced materials based on experimental and computational quantum mechanical method
2. Development of new materials, high performance of electrochemical devices
3. Correlation of existing materials properties and their fundamental knowledges such as condensed matter physics, quantum mechanics and solid state ionic.

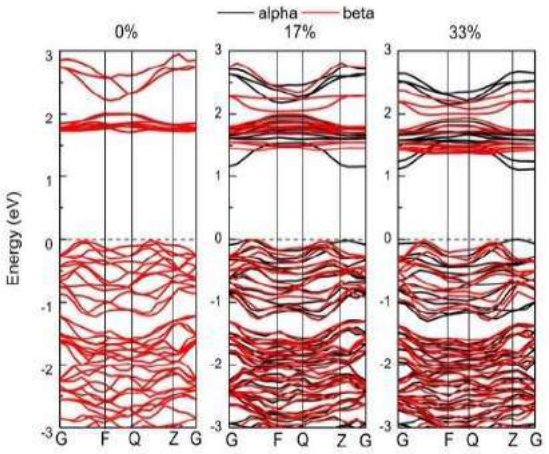
Knowledge and scientific skill transfer to students and other collaborators includes synthesis, characterization and computational techniques

5.2 Research Highlights

5.2.1 Design and Discovery of Novel Room Temperature Multiferroic $Bi_{1-x}Ga_xFeO_3$ Materials: A combined theoretical and experimental Approach

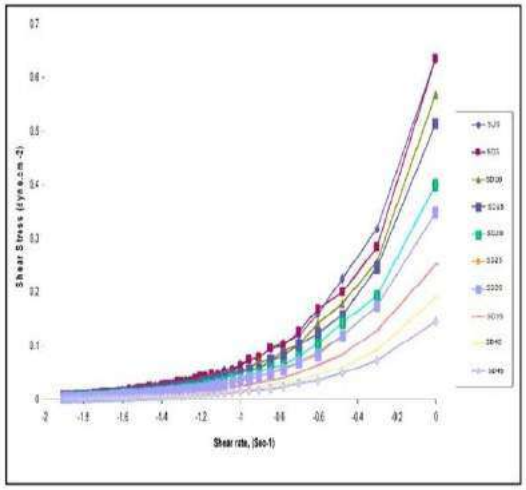
$BiFeO_3$ is known for its promising candidate to be a room temperature multiferroic due to its high phase transition temperature. This causes the material to produce extra functionalities that usually cannot be handled by a single ferroic order material. However, $BiFeO_3$ comes with problems such as high leakage current and weak magnetization. In this work, we develop a combined first principles calculation and hydrothermal synthesis method to predict the novel material $Bi_{1-x}Ga_xFeO_3$ in antiferromagnetic *R3c* phase and improve the desired optimal properties. Our investigation predicts such material on theoretical approach firstly, which then the material was design experimentally. The synthetization so far aligned with theoretical studies regarding phase structure prediction and energy gap. Further experimental analysis may provide significant insight to strengthen our theoretical prediction and results. Also, this technique could be an alternative to the conventional experiment method, as it reduces try and error practice and greener approach.

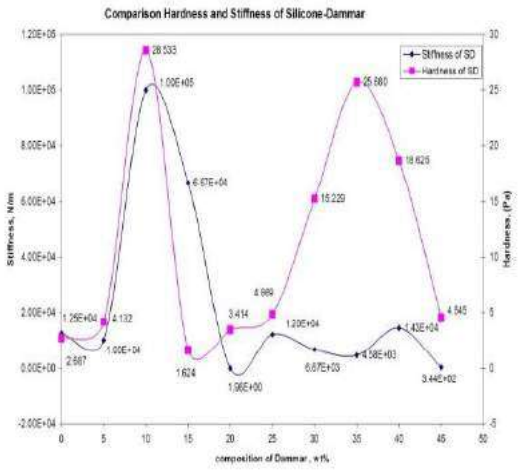




5.2.2 Silicone-Dammar Thin Film as Organic Coating

Most silicone resins contain methyl and phenyl group. The phenyl groups will improve heat resistance, flexibility and compatibility with pigment. The use of natural resin as additional materials to produce new formulation of natural and synthetic binder especially dammar and mastic resin are already popular and a mixture of paint varnishes. In this studies, properties of Silicone-Dammar thin film as organic coating materials at various weight percent of Silicone and Dammar were mix to make a thin film on aluminum Q-panel. Properties like rheology, cross hatch test, nanoindentation, and Electrochemical Impedance Spectroscopy were investigated.





5.2.3 Alkaline solid polymer blends electrolyte films

Alkaline solid polymer blends electrolyte (ASPBE) films comprising a blend of poly(vinylalcohol) (PVA) and poly(vinylpyrrolidone) (PVP), potassium hydroxide (KOH) as ionic dopant, ethylene carbonate (EC) and propylene carbonate (PC) as plasticizer have been prepared by solution casting technique by varying the polymer blend-ionic dopant-plasticizer concentration ratio systematically. The PVA combined

with PVP had good mechanical strength performed by tensile strength (TS) test. X-ray diffraction (XRD) studies have been conducted to investigate the complexation in the alkaline solid polymer blends electrolyte. The XRD results revealed that the amorphous domain of PVA was increased when the PVP was blended. The variation in film morphology was examined by scanning electron microscopic (SEM). The thermal properties of these films were performed using differential scanning calorimeter (DSC) and the result has confirmed the miscibility between the polymeric components. The conductivity was studied using complex impedance spectroscopy to investigate ionic conduction in blending PVA/PVP, PVA/PVP-KOH, PVA/PVP-KOH-EC and PVA/PVP-KOH-PC electrolyte systems. The complex impedance spectroscopy results revealed that the high-frequency semicircle was due to the bulk effect of the material.

5.3 Group Information and Background of Members

Name of RIG	**ELECTROACTIVE MATERIALS (EM)**
Leader	Dr. Mohamad Fariz Mohamad Taib
Tier	5
RIG Code	CoRe108/T5/2016(13)/FMIA(08)
Registration Year (Senate Approval)	2016
UiTM Niche Area	Advanced Materials for Energy Applications
RIG Niche Area	Research on Electrochemical Devices (Synthesis & Computational)

DR. MOHAMAD FARIZ BIN MOHAMAD TAIB
Faculty of Applied Sciences
Expertise:
Computational Materials Sciences, Ferroelectric, Half-metallic Materials

DR. MUHAMAD KAMIL BIN YAAKOB
Faculty of Applied Sciences
Expertise:
Multiferroic, Condensed Matter Physics, Computational

DR. ROSNAH BINTI ZAKARIA
Faculty of Applied Sciences
Expertise:
Coating, Solid State Ionic

ASSOC. PROF. DR. OSKAR HASDINOR BIN HASSAN
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NAZLI AHMAD AINI
Faculty of Applied Sciences
Expertise:
Magnetic Materials, Fuel Cell, Polymer Electrolyte

FAIZATUL FARAH HATTA
Foundation
Expertise:
Polymer Electrolyte, Battery

NOOR 'AISYAH JOHARI
Foundation
Expertise:
Polymer Electrolyte, Battery

NO	NAME	FACULTY	AREA OF EXPERTISE
1	DR. MOHAMAD FARIZ BIN MOHAMAD TAIB (HEAD of GROUP)	Applied Sciences	Computational Materials Sciences, Ferroelectric, Half-metallic Materials
2	ASSOC. PROF. DR. ING OSKAR HASDINOR HASSAN	Ceramic Department, Art & Design	Ceramics, Cathode Materials, Fuel Cell, Computational
3	DR. ROSNAH BINTI ZAKARIA	Applied Sciences	Coating, Solid State Ionic
4	DR. NAZLI AHMAD AINI	Applied Sciences	Magnetic Materials, Fuel Cell, Polymer Electrolyte
5	DR NOR KARTINI JAAFAR	Applied Sciences	Solid State Ionic/Advanced Material
6	DR. MUHAMAD KAMIL BIN YAAKOB	Applied Sciences	Multiferroic, Condensed Matter Physics, Computational
7.	DR NURUL IZRINI IKHSAN	Applied Sciences	Graphene
7	DR SITI ZAFIRAH ZAINAL ABIDIN	Applied Sciences	Solid State Ionic/Advanced Material
8	NOOR 'AISYAH BINTI JOHARI	UiTM Dengkil	Polymer Electrolyte, Battery
9	FAIZATUL FARAH HATTA	UiTM Dengkil	Polymer Electrolyte, Battery

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2. R Zakaria, AH Ahmad, “Rheology behaviour of modified silicone-dammar as a natural resin coating”, AIP Conference Proceedings 1674 (1), 2015
3. R Rozilah, MK Yaakob, Z Mohamed, AK Yahya, “ Effects of on-site Coulomb interaction (U) on the structural and electronic properties of half-metallic ferromagnetic orthorhombic Pr0.75Na0.25MnO3 manganite: a LDA + U calculation and experimental study”, Materials Research Express 4 (6), 2017

6.0

SURFACE COATING RESEARCH

Junaidah Jai, Norliza Ibrahim, Istikamah Subuki, Anizah Kalam, Norsuhana Mohd Yusof, Rafeqah Raslan, Nurashikin Zamanhuri

6.1 Introduction

Surface coating (SC) research group is formed to focus research on development of surface coating protection for various applications.

Many activities emphasize on the following areas:

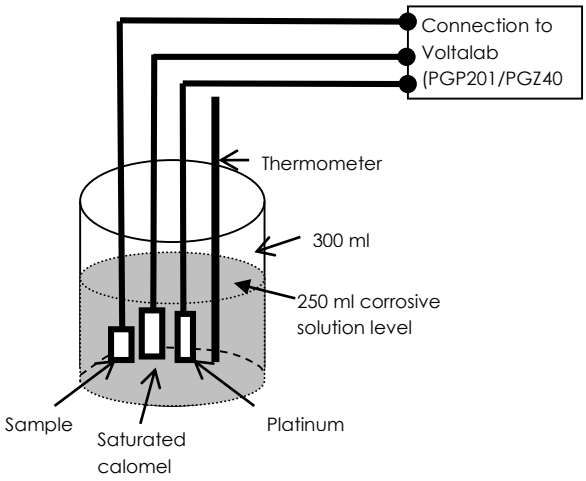
1. Development of corrosion inhibitor for metal protection.
2. Development of film coating material for food packaging incorporated with antimicrobial and antioxidant agents from plant extract.
3. Encapsulation of essential oil from plant extract to be used as antimicrobial and mosquito repellent in household products.
4. Development of palm leaves extract as reducing agent in the synthesis of nano-particle and recovery of precious metals from electroplating waste

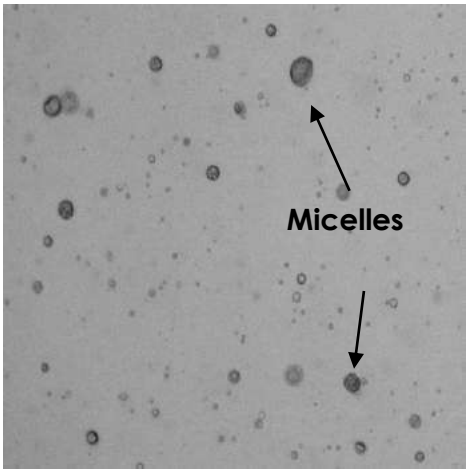
6.2 Research Highlights

6.2.1 Palm oil as corrosion Inhibitor for aluminium car radiator

Aluminium (Al) is an amazing material due to its low cost, lightweight and corrosion resistance. However, Al is easily corroded when exposed in solution containing pitting agents. Suitable corrosion inhibitor should be used and palm olein has a promising characteristics. For this work, formulation of palm olein (PO) as corrosion inhibitor for Al in aqueous solution was developed. Tween 20, hexane and diethyl triamine were used as the additives and the formulated inhibitor was labeled as POT20HA. The X-ray diffractometer (XRD) spectrum revealed that the POT20HA was an amide compound. The inhibition efficiency (IE) and behaviour of the POT20HA were determined through weight loss (WL), potentiodynamic polarization (PP) and electrochemical impedance spectroscopy (EIS). Scanning Electron Microscopy (SEM) coupled with Energy Dispersion X-ray analysis (EDAX) was used to examine the morphology of the corroded Al 6061. The WL test had shown that the IE increased with increasing concentration of POT20HA at all temperatures under study. However, the IE decreased with increasing of temperature and immersion time. The PP study revealed the POT20HA as a mixed type of inhibitor, which is capable of protecting both the anodic and cathodic reactions of the corrosion process. The EIS study had shown the ability of POT20HA in forming protective passive film on Al 6061 surface. The thickness of the passive film increased accordingly with the increase in concentration but decreased with increasing temperature. The corrosion tests showed that POT20HA adsorbed on the Al 6061 surface through physical adsorption according to the Langmuir isotherm relationship. The adsorption mechanism of POT20HA on the Al 6061 was through protonation of

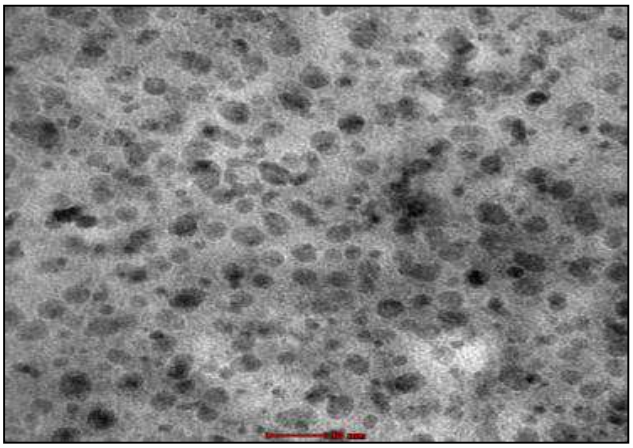
micelles by the HCl solution. The protonated micelles, with the presence of Cl^- ions, adsorbed both on the cathodic and anodic sides of the corroding surface. Performance test had shown that the POT20HA has performed as an anticorrosion with glycerin as a coolant in an Al car radiator.





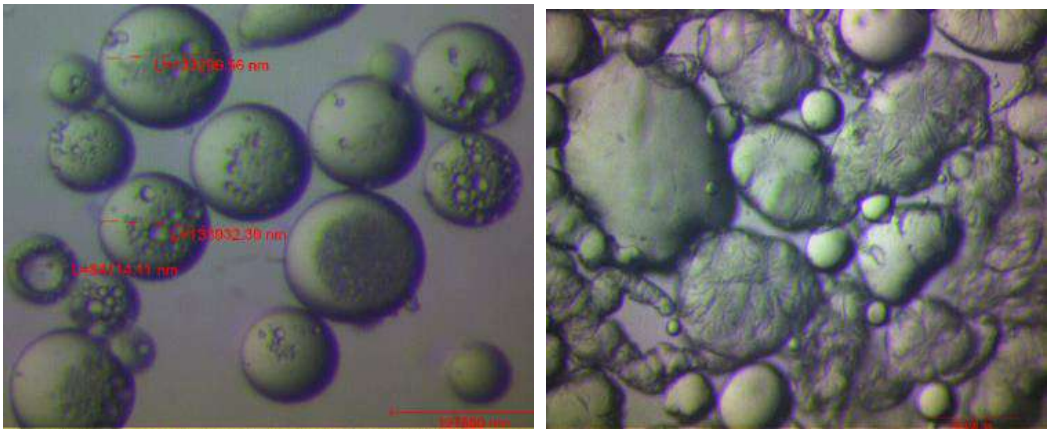
6.2.2 Palm oil leave extract as reduction agent - nanoparticles

Platinum nanoparticles were biologically synthesized by reducing H_2PtCl_6 with palm leaves extract at room temperature. The effect of metal salt concentration and plant extract percentage on platinum ions conversion and the size distribution of the platinum nanoparticles were studied. The result showed that the conversion of platinum ions reached 87.2% and the platinum nanoparticles with average size of 1.67 ± 0.11 nm were obtained by reducing 1mM of H_2PtCl_6 with 10% of palm leaves extract. FTIR result revealed that compounds such as hydroxyl and carbonyl act as reducing agents for platinum ions reduction while proteins amine groups stabilized the nanoparticles. EDX spectrum confirms the presence of platinum element in the nanoparticles.



6.2.3 Encapsulated citronella oil as mosquitoes repellent agent in water based paint

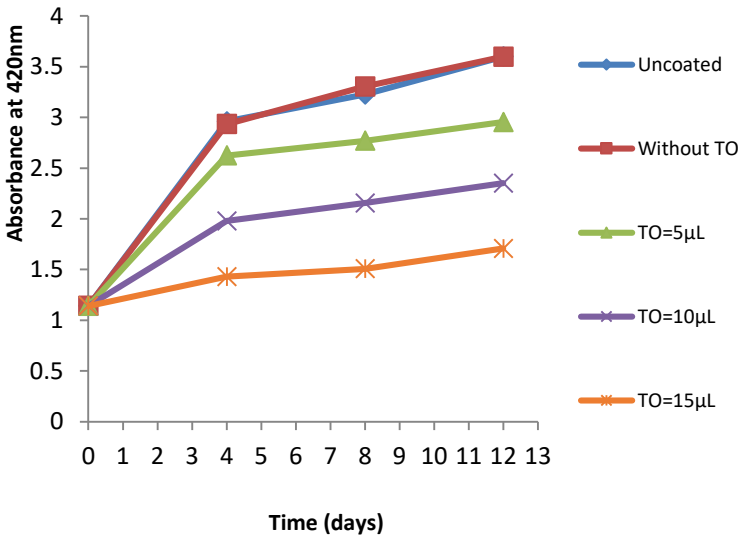
The aim of the study is to produce a CO paint as mosquito repellent and able to provide protection for more than a year. The performance of the CO paint indicated by its mosquito repellency properties and basic standard paint characteristic which are paint VOCs content, adhesion and viscosity. To provide control release, the CO was encapsulated via simple and complex coacervation methods. Both method have provided good efficiency with encapsulation efficiency around 94%. Comparison was made for capsules morphology to find suitable capsules to be added in water based paint. From the observation, capsules from complex coacervation has given better morphology to be added in water based paint. The capsules wall able to sustain in wet and capsule wall start ruptured in dried conditions. Basic water based paint is required in the study because addition of CO has increase the viscosity of the paint and emission of chemical VOCs from the commercial paint was considered can decrease the concentration of citronella compounds in air thus decrease its effectiveness as repellent. CO was added in basic water based paint at 0 to 5 %v/v. The study found that, 3.5 % CO paint was good enough to be function as mosquito repellent. But, release kinetic study found that the paint able to release the citronella in 4 days only. Encapsulated citronella oil (ECO) in paint has lower release kinetic thus able to provide longer release duration. 12% ECO paint able to provide protection for 1 year and 236 days. With the calculated dosage, the paint able to give 100% repellency to A. *aegypti*.



6.2.4 Tumeric oil as the antioxidation agent in edible coating film

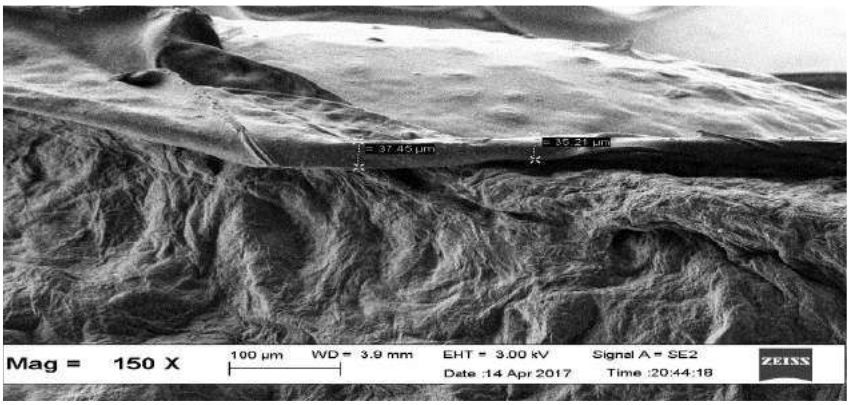
Turmeric oil (TO) has been studied for its potential as an antioxidation agent in starch edible coating for fresh cut apples and its degree of oxidation wasanalysed. TOincorporate with starch edible coating was examined using FT-IR Spectroscopy to determine the presence of secondary metabolites. The presence of alcohol and aromatic ring in the edible coating film proved that the secondary metabolites from TO were existed. The fresh cut apples were underwent the sensory test and six out of tenpanellist concluded that coated fresh cut apples have good appearance and surface colour. Fresh cut apples were coated with edible coating incorporated with different concentrations of TO (uncoated, 0µL, 5µL, 10µL, 15µL. Percentage weight loss for 15µL were the least which were 1.98% (day 6) and 3.95% (day 12). Colour measurement were done for few days and it shows that the total colour difference (ΔE) for 15µL were the lowest. Thus, the oxidation activities for 15µL is the slowest

compared to the others. These can be proved through the degree of oxidation analysis using UV-Vis spectroscopy. Uncoated fresh cut apples havethe highest degree of oxidation whilethose with 15µLhave the lowest. This study can be illustrated that the oxidation activities of fresh cut apples could be postponed using edible film incorporated with TO.



6.2.5 Curcuma longa L. on chitosan–starch based edible coating

The ability of chitosan-starch based coating to extend shelf life of strawberry were studied. The main objectives of this paper is to study the effects of different concentrations (20, 15, 10 and 5 µL) of *Curcuma longa L.* (CUR) essential oil into chitosan-based edible coating on surface tension in order to increase the effectiveness of the coating. CUR or turmeric is one of the commercially planted herbs in Malaysia for its phytochemical benefits. Application of edible coating using dipping technique has been analysed and evaluated for their effectiveness in extending shelf life of fruits. Surface tension was analysed to investigate the adhesion properties. The best CUR concentration was 15 µL with the optimum surface tension was found to be 31.92 dynes/cm.



6.3 Group Information and Background of Members

Name of RIG	SURFACE COATING RESEARCH GROUP (Coating SCRG)
Leader	Assoc. Prof. Dr. Junaidah Jai
Tier	5
RIG Code	CoRe108/T5/2016(13)/FMIA(17)
Registration date (Senate Approval)	16 APRIL 2014
UiTM Niche Area	Advanced Manufacturing & Automation
RIG Niche Area	Material science and engineering on surface protection.

Dr. Norliza Ibrahim
Faculty Of Chemical Engineering
Expertise: Ceramic mambrane

Rafeqah Raslan
Faculty Of Chemical Engineering
Expertise: Product from natural resource

Dr. Anizah Kalam
Faculty of Machanical Engineering
Expertise: Fracture Mechanics

Assc. Prof Dr.Junaidah Jai
Faculty of Chemical Engineering
Expertise: Corrosion Inhibitor

Dr. Istikamah Subuki
Faculty Of Chemical Engineering
Expertise: Powder Metallurgy

Noorsuhana Mohd Yusof
Faculty Of Chemical Engineering
Expertise: Food coating

Norashikin Zamanhuri
Faculty Of Chemical Engineering
Expertise: Extraction

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7.0

NANOCOMPOSITE MATERIALS & INDUSTRIAL APPLICATION RESEARCH

Mohd Nazarudin Zakaria, Noor Najmi Bonnia, Siti Norasmah Surip, Mansur Ahmad and Mimi Azlina Abu Bakar

7.1 Introduction

Research activities emphasize on the following areas:

1. Nanocomposites
2. Nanomaterials
3. Synthesis of nanomaterials & nanofibers
4. Wood Composites
5. Thermoset Polymer
6. Materials Science
7. Advanced Materials
8. Bacteria Cellulose
9. Silver Nanoparticles

Consultation Services:

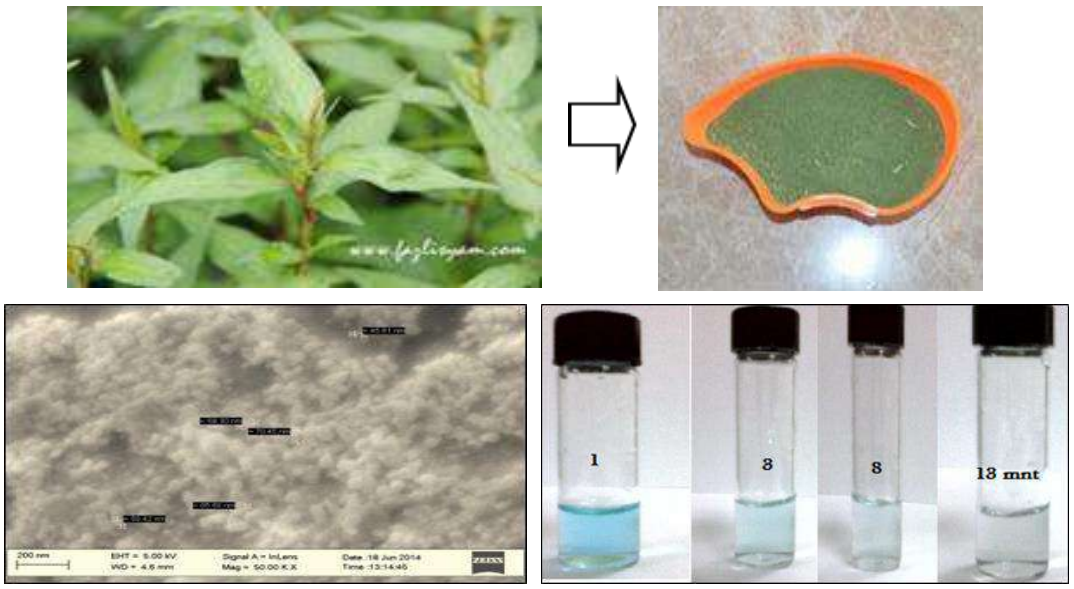
1. Polymeric and Composites Materials
2. Wood Composites
3. ESCR testing /degradation behaviour of polymer composites based product.
4. Mechanical, Thermal, Physical, Morphological properties of nanocomposite materials.
5. Biomechanic

7.2 Research Highlights

7.2.1 Green Biosynthesis Of Silver Nanoparticles Using 'Polygonum Hydropiper' And Study Its Catalytic Degradation Of Methylene Blue

The green synthesis of silver nanoparticles with the small size and high stability paved the way to improve and protect the environment by decreasing the use of toxic chemicals and eliminating biological risks in biomedical applications. Plant mediated synthesis of silver nanoparticles is gaining more importance owing its simplicity, rapid rate of synthesis of nanoparticles and eco-friendliness.. In this study, focus on biosynthesis of silver nanoparticles using *Polygonum hydropiper* extract and its catalytic degradation of hazardous dye, methylene blue has been highlighted. The rapid reduction of silver (Ag) ions was monitored using UV-Visible spectrophotometer and showed formation of silver nanoparticles within less than one hour with maximum absorption of silver nanoparticles at 430 nm. The major functional groups present in the synthesized silver nanoparticles responsible for the formation of silver

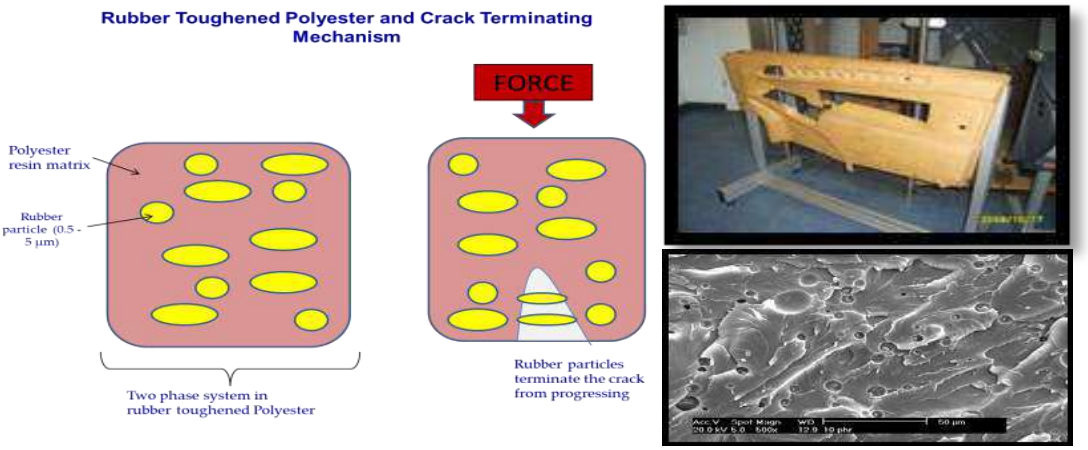
nanoparticles are identified using Fourier Transform Infrared spectrophotometer (FTIR). Field Electron Scanning Microscope (FESEM) was used to characterise the nanoparticles synthesized using *P.hydropiper.* The morphology of silver nanoparticles was predominantly spherical and aggregated into irregular structure with average diameter of 60 nm. In addition, this report emphasizes the effect of the silver nanoparticles on the degradation rate of hazardous dyes by sodium borohydride ($NaBH_4$). The efficiency of silver nanoparticles as a promising candidate for the catalysis of organic dyes by $NaBH_4$ through the electron transfer process is established in the present study.



7.2.2 Superb Structural Of Toughened Biocomposites For High End Applications

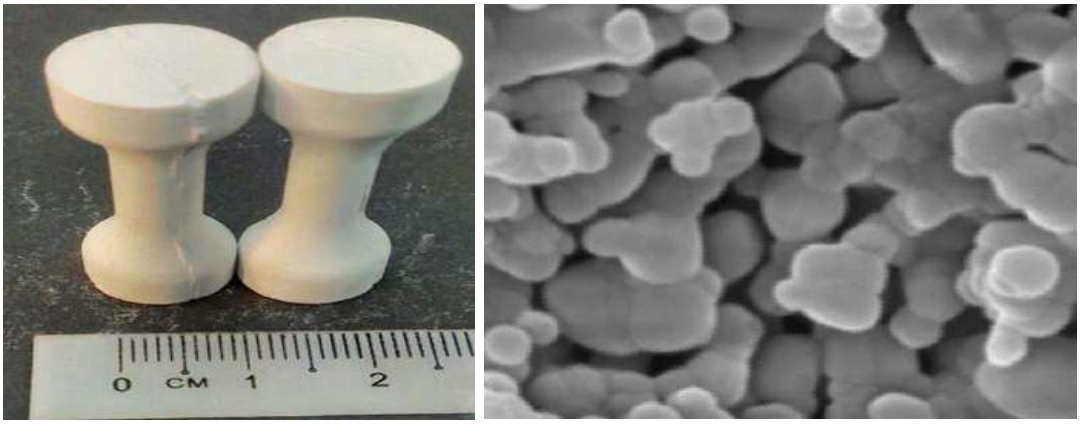
Brittleness of thermoset polyester due to cross linking process enhances the idea of producing rubber toughened polyester composite. Rubber toughened polyester - kenaf composite were prepared by adding various percentage of kenaf fiber in unsaturated polyester resin and subsequently cross linked using methyl ehtyl ketone peroxide and accelerator Cobalt Octanoate. Liquid Natural Rubber (LNR) was also added in producing this composite. Addition of LNR promotes excellent properties on fracture toughness, impact strength, flexural strength and hardness compared to without LNR. Even though polyester and rubber particles are in different phases, not blended, still the rubber particles can help the crack from propagate and increase the strength of thermoset polymer. Environmental stress cracking (ESC) in plastics can be explain by the failure of the polymeric materials at room temperature due to continuously alternating internal and/or external stresses generally in the presence of surface-active wetting agents that is also known as stress cracking agents. From ESCR result, after being exposed to 4 difference environments (sea water, distilled water, soil buried & natural weather) for 3 months shows that rubber toughened polyester composite have high resistance to active environment and suitable for outdoor used. This is a quality local product from a combination of good properties polyester and high performance natural fiber; kenaf suitable for many applications such as in automotive and construction sectors. Product also expected to be applied

in the interior of passenger cars and truck cabins. The advantages of rubber toughened polyester have widened the applications of polyester resin replacing epoxy within the area of outdoor used furniture, automotive, transport, aircraft and sporting sectors.



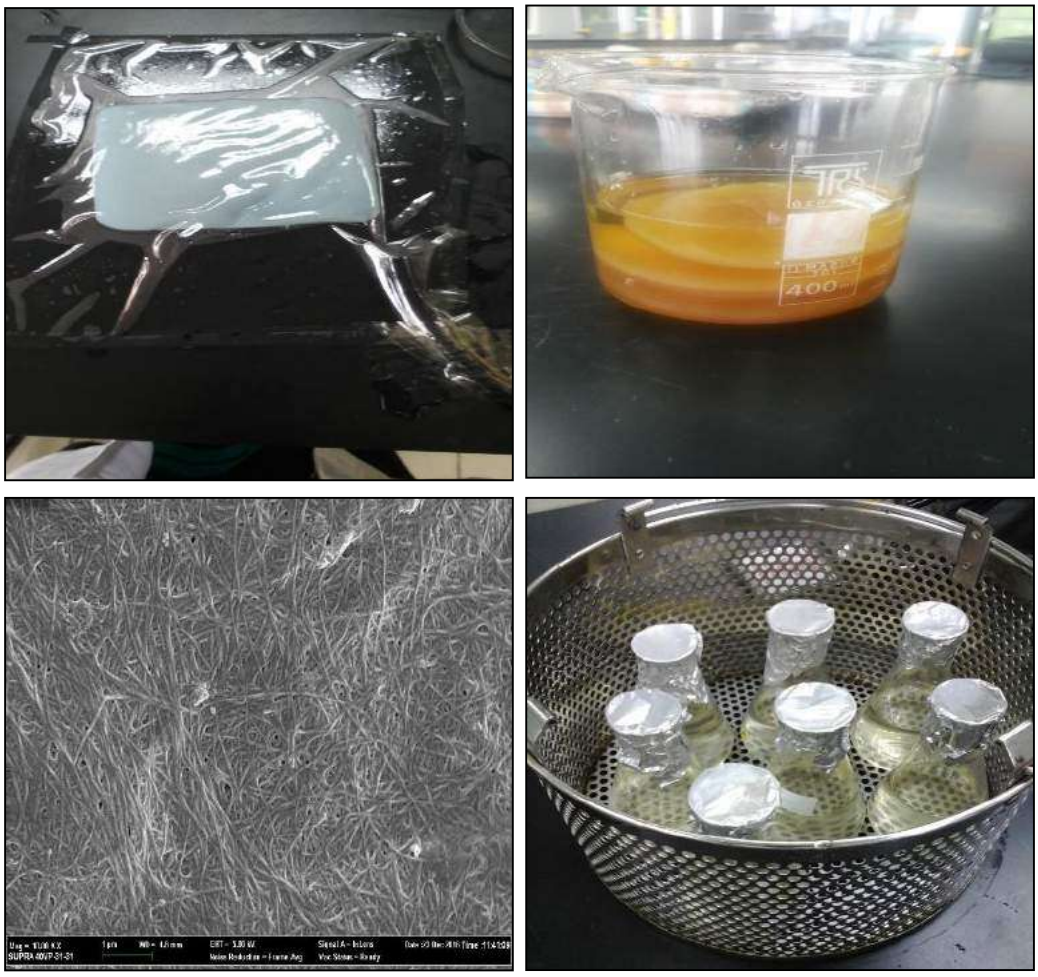
7.2.3 Dual Function of Palm Stearin in Processing of Hydroxyapatite (HAp) Scaffold

Binder in ceramic injection molding (CIM) is important as it acts as a temporary vehicle to support the ceramic powder during mixing and injection molding. Besides promoting good adhesion to powder during mixing and good flow properties during injection moulding, the binder should also exhibit sufficient dimensional rigidity and strength towards the process. Conventional CIM requires at least two binder systems which are known as (i) primary binder (low melting point) and (ii) backbone binder (high melting point). There are many binder system being used by CIM industries, however non reporting the use of single binder system, particularly for biomedical scaffold implant. The main objective of this work is to investigate the potential of local binder system namely palm stearin to be used as main binder system without employing the backbone constituent. The results show that the palm stearin exhibits promising behaviour especially during mixing and injection moulding, whereby temperature for both processes can be reduced significantly. Besides, the parts are easily sintered using a single step firing process at an elevated temperature. The scaffold structure developed encourages osseointegration between bone tissue and implant, thus minimizing the problems of stress shielding effects for long term implantation.

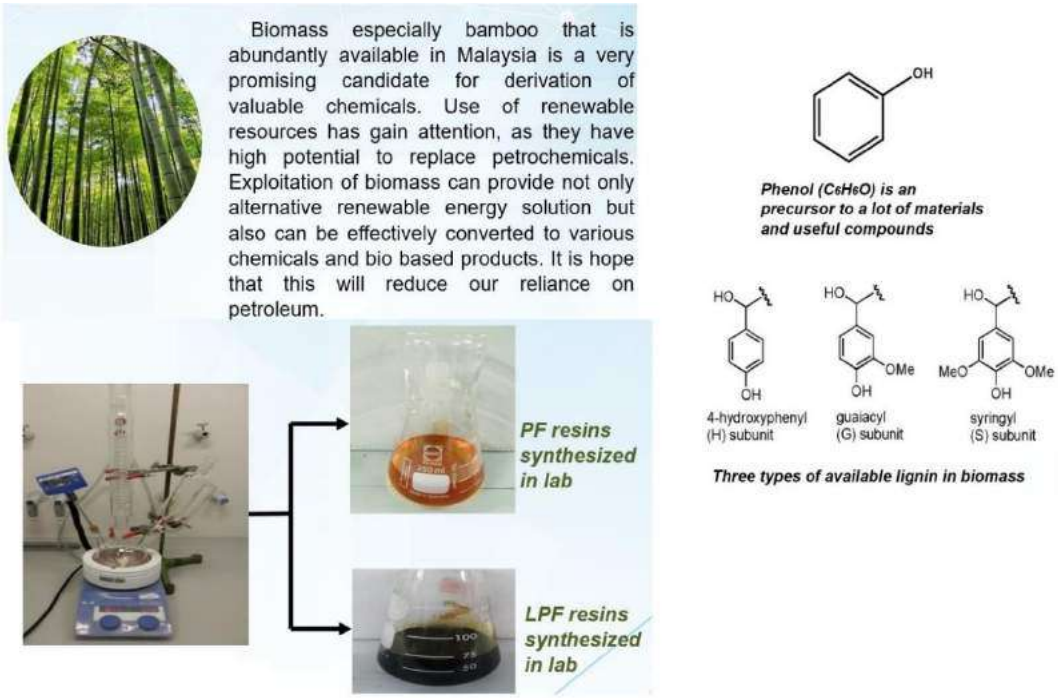


7.2.4 Effect of growth times on the physical and mechanical properties of hydrophobic and oleophilic silylated bacterial cellulose membranes

Bacterial cellulose is an extracellular natural byproduct of the metabolism of various bacteria. Its physical and mechanical properties were determined by growth period, method of cultivation either static or agitate, fermentation condition and medium. This paper presented works done on the effect of culture time on the physical and mechanical properties of silylated bacteria cellulose membranes. Bacterial cellulose (BC) growth under 4, 5, 6 and 7 days had been used as a natural reinforcement material and silane as a hydrophobic coating material. With extended culture time, the tensile strength and tensile modulus were increased linearly as result of more compact structure. Due to hydrophobic properties of silane, the water absorption and thickness swelling improved correspondingly. Contact angle testing using three different liquid proven the functionality of silane as hydrophobic and oleophilic coating agent. The experimental results suggested that hydropobic and oleophilic silylated bacteria cellulose membranes with controlled growth time could be prepared and regarded as a reusable oil spills membrane.

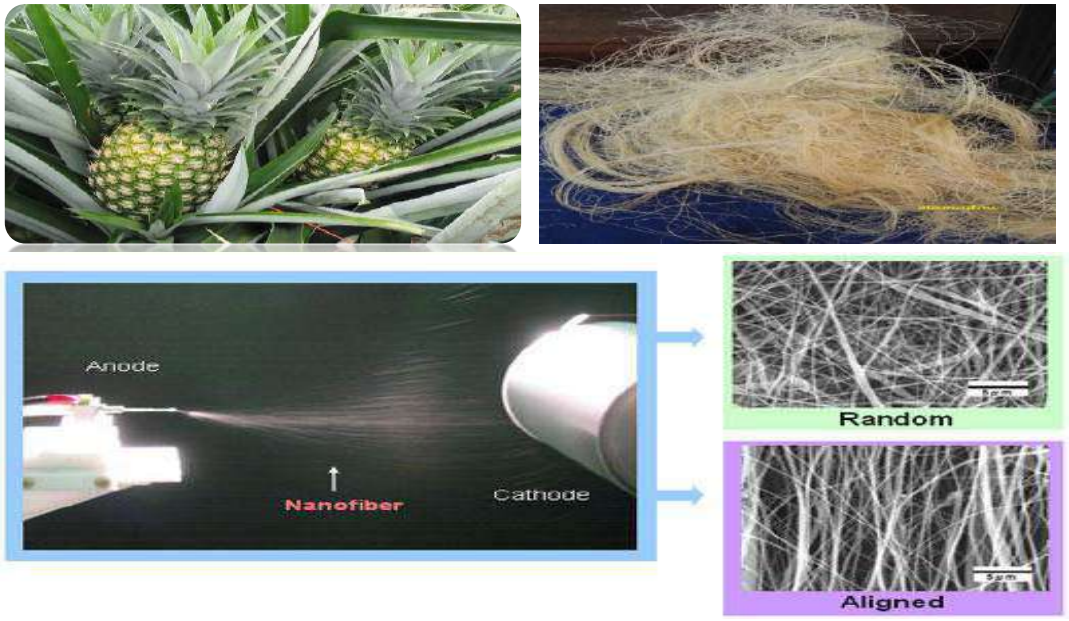


7.2.5 Green Phenolic Resins from Bamboo



9.2.6 Electrospinning Of Pineapple Leaf Nanofibers (PALF)

Electrospinning technique provides a straightforward and highly versatile method for processing polymer solutions into continues fibers with diameters ranging from a few micrometers to a few nanometers (*R.P.O Santos et al.,2015*). In this study, mats of nanofibers were prepared via electrospinning method. Lignocellulosic pineapple leaf fibers (PALF) were dissolved in trifluoroacetic acid (TFA) solutions. Optimum ratios of PALF were studied.



7.3 Group Information and Background of Members

Name of RIG	NANOCOMPOSITE MATERIALS AND INDUSTRIAL APPLICATIONS RESEARCH GROUP
Leader	Dr Mohd Nazarudin Zakaria
Tier	5
RIG Code	CoRe81/T5/2015(15)/FMIA(11)
Registration Year (Senate Approval)	2015
UiTM Niche Area	INDUSTRY 4.0
RIG Niche Area	Nanocomposite , nanomaterials, Synthesis of nanomaterial & nanofibre, Wood composites., Polymeric Materials,Materials Science, Advanced Materials, Bacteria cellulose , Material Processing & instrumentation , manufacturing products.

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Rheological Properties Used for Ceramic Injection Moulding (CIM), Advanced Materials Research 1134, 220-224, 2016

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8.0

NANO-ELECTRONIC (NET) RESEARCH

Mohamad Hafiz Mamat, Ahmad Sabirin Zoolfakar, Zurita Zulkifli, Shafinaz Sobihana Shariffudin, Puteri Sarah Mohamad Saad, Norulhuda Abd Rasheid, Uzer Mohd. Noor, Mohamad Fariz Mohamad Taib

8.1 Introduction

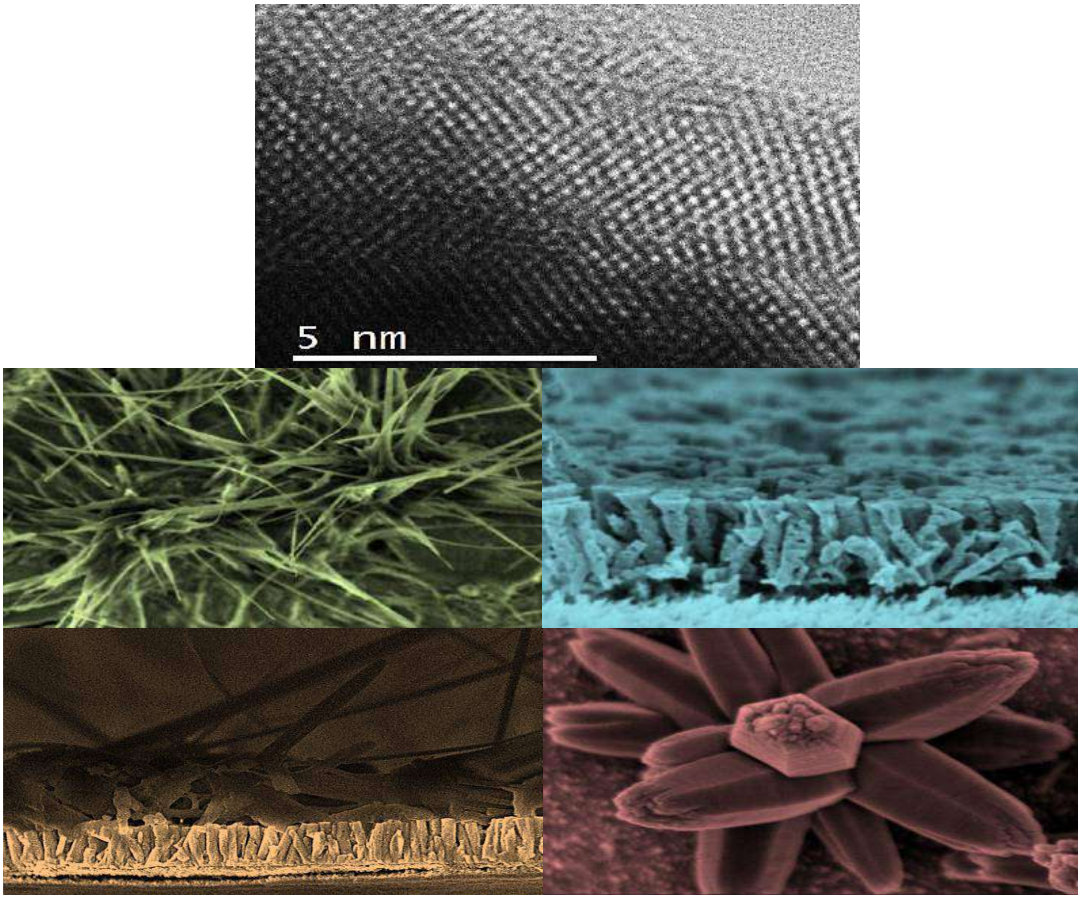
Niche Area: Nanoelectronics

- Optical sensors (UV and Vis sensors)
- Humidity sensors
- Gas and chemical sensors (oxygen, ethanol, etc)
- Solar cells (DSSC, organic solar cells)
- Nanometal oxide related research (ZnO, CuO, NiO, NbO, TiO2, etc)
- Nanocarbon and polymer related research (graphene, CNTs, amorphous carbon,etc)

8.2 Research Highlights

8.2.1 Novel Heterogeneous Zinc Oxide/Tin Oxide Nano-Array Films: Towards Development of Facile and High Quality Humidity Sensors

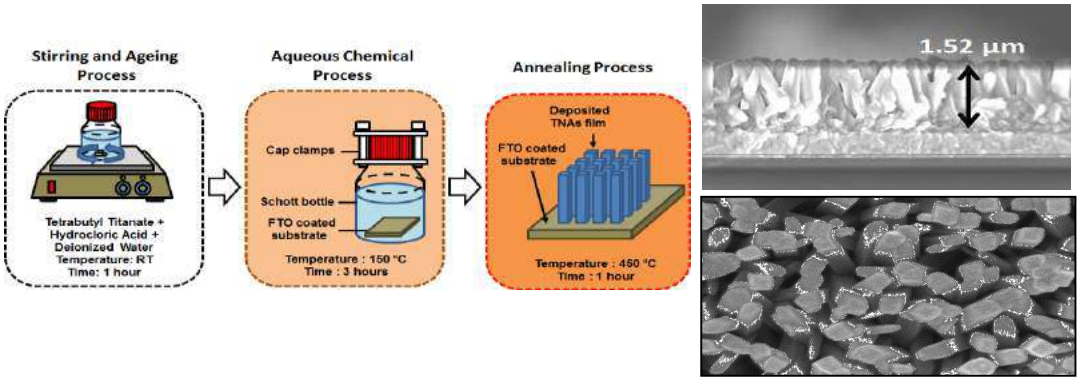
Humidity sensors have been widely fabricated because of their broad applications in meteorology, health science, food science, and agriculture. Uncontrollable amount of humidity level in ambient can bring damages to many equipment and devices. This will cost a lot for the maintenance and repairing process. Thus, a good humidity sensor is required to control the humidity level. Low surface area, high surface defects, and poor electron mobility induced poor performance of humidity sensor. Hence, we invented highly sensitive humidity sensor comprising of zinc oxide (ZnO)/tin oxide (SnO_2) nanocomposited arrays as the sensing membrane using a facile sol-gel immersion method. Besides the simple and low cost process, this immersion method involved a use of very low deposition temperature (95 °C), yet producing high quality film. Zinc oxide (ZnO) and tin oxide (SnO_2) are semiconducting materials which meet the criteria needed by the current semiconductor devices industry. They are known to be abundantly available in nature which ensures the availability of the materials source. Excellent properties possess by ZnO and SnO_2 such as non-toxicity, highly sensitive, and low cost make them very important to the device fabrication.



Structural images of the sensors

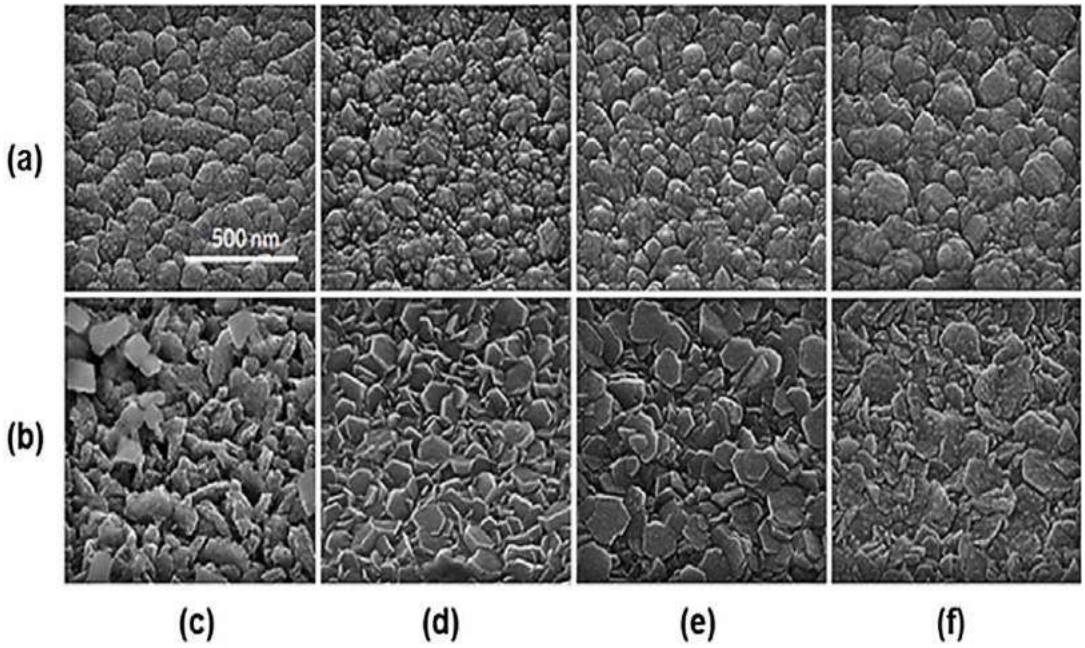
8.2.2 Self-Biased UV Photosensor Composed of Titanium Dioxide Nanorod Arrays Fabricated by Facile One-Step Aqueous Chemical Process

Ultraviolet (UV) monitoring is extremely important and extensively used in various applications such as phototherapy treatment, flame detection, environmental monitoring and others. Therefore, a reliable UV photosensor is required to monitor the UV level. However, most conventional sensors require an external supplies, which prominently reduced the independency and mobility of the sensing system. Furthermore, energy supply has becoming one of the great challenges for the large-scale area applications. Hence, we designed a self-biased photoelectrochemical cell (PEC)-based UV photosensor composed of titanium dioxide (TiO2) Nanorod Arrays (TNAs) fabricated by facile aqueous chemical process. Besides the simple and low cost method, this aqueous chemical process involves the use of low deposition temperature (<150 °C), yet producing a high quality film. TiO2 is intrinsically prone to UV irradiation, which makes it applicable for the application. It is widely used material in present industries and abundantly available in nature. Excellent structural, optical and electrical properties of TiO2 make it excellent for the fabrication of PEC-based device system.



8.2.3 Engineering and Tuning Transition Metal Oxides via Electric Field Driven Technique

Transition metal oxides are functional materials that offer a large number of applications in various areas, owing to their diverse properties including their versatile electronic band structure, optical, electrical, magnetic, mechanical and thermal specifications. However, these properties should be adjusted to enhance functionalities of such transition metal oxides for each specific application. Engineering and tuning transition metal oxides syntheses' parameters such as changes in the temperature and pressure, the incorporation of seeds or templates, nanostructuring and introducing foreign atoms or molecules *via* doping or intercalation as well as applying electric, mechanical, optical and/or magnetic fields, provide pathways for the enhancement in their functionalities.The interest in engineering and tuning procedures has been fuelled by the recent advances in advanced synthesis processes, which now allow better control over the electronic structure, crystallinity, morphology, and stoichiometry of the transition metal oxides. Such abilities have led to newer opportunities in disciplines as diverse as physics, chemistry, biology, medicine and engineering. Currently, NET‘s researcher have conducted several experiments by employing “nanostructuring” as the core method for tuning and engineering transition metal oxides which uses for the development of model sensors, solar cells and storage devices with enhanced properties. Nanostructured transition metal oxides can potentially offer remarkable mechanical, electrical, magnetic, thermal and optical properties, in comparison to their bulk counterparts, endowed by confining the dimensions to nano size ranges.

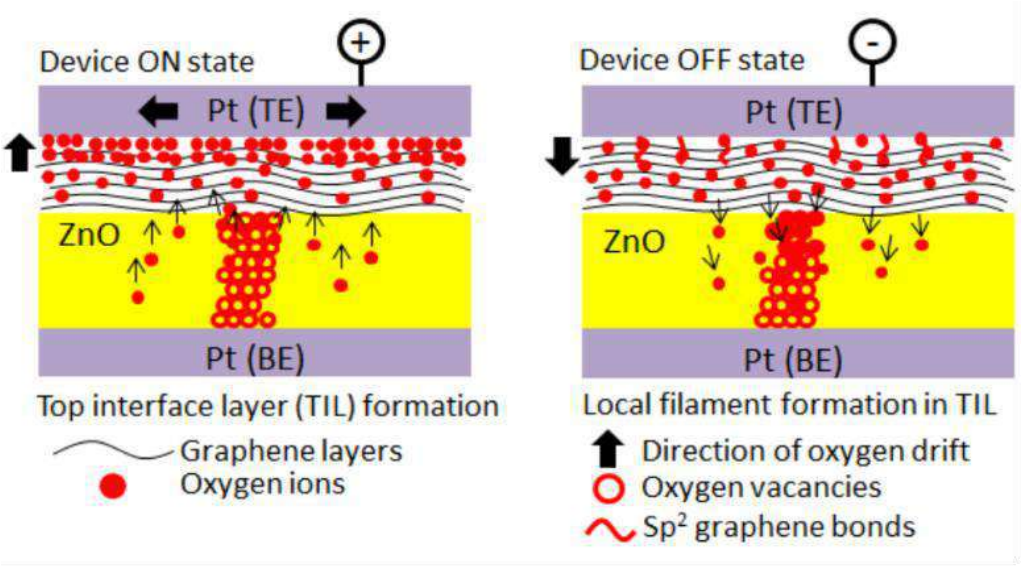


SEM images of the surface of ZnO samples (a, c-f) RF sputtered, (b, c-f) electrodeposited under various sputtered powers, (c) 60 W, (d) 80 W, (e) 100 W and (f) 110 W. Scale bars are similar for all figures.

8.2.4 Transfer of Opaque Liquid Graphene onto Substrate for Transparent and Large Area Graphene Film Using Low Temperature Water Bath for Memristor Application

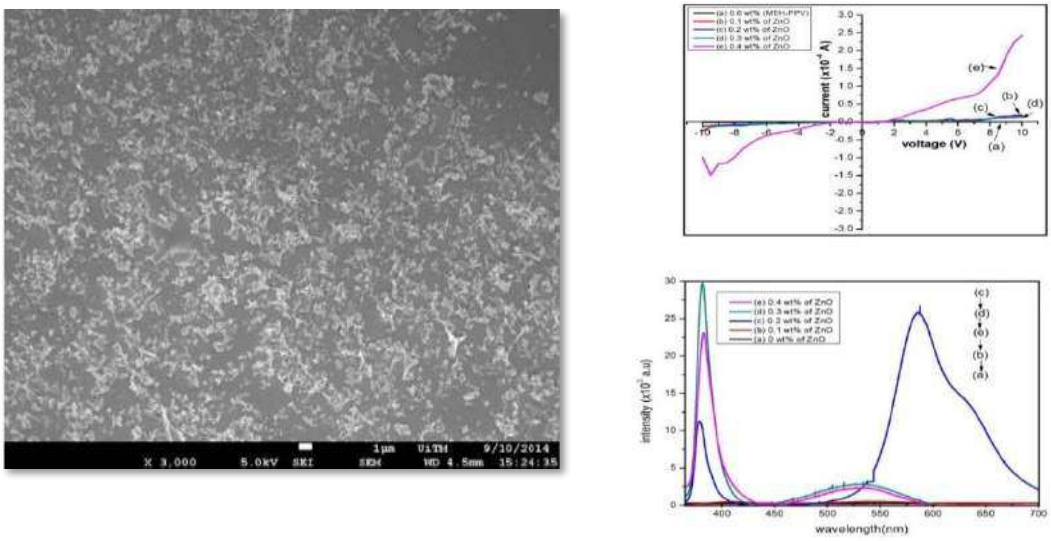
This research demonstrates the transfer of graphene in water solution to a thin film at low temperature using water bath. Graphene in water solution (highly opaque) was transferred onto Platinum/Glass (Pt/Glass) substrate and also on ZnO film with the unique technique that not involves any additional chemicals. The transferred graphene is characterized using FESEM, Raman spectroscopy and I-V measurements. Raman spectra and FESEM images show the thin film exhibited multilayers graphene on ZnO surface. The multilayer graphene is highly transparent as the ZnO surface morphology can be observed underneath the graphene layer. This transfer method enables us to transfer graphene onto ZnO thin film for memristive devices. Without a layer of graphene film on ZnO, the hysteresis loop of pristine ZnO memristor easily degraded and the resistance ratio dropped more than 50% after several time repeating the ON and OFF state. This condition leads to the unstable switching cycle. Our finding shows, the graphene on ZnO film improved the stability switching cycle for a memristor device. The insertion of graphene can limit atomic diffusion, altering the oxygen vacancy interactions between metal and insulator and thus helped increase the endurance and improving the stability of the device. During the ON state, positive voltage attracts the oxygen ions within the oxide bulk to the top electrode (TE), leaving behind oxygen vacancies that form the conductive filament (CF). As the voltage becomes higher, more ions accumulate at

the TE, leaving behind enough oxygen vacancies to form a complete CF throughout the oxide bulk. The ions are trapped at the Graphene layer and are unable to interact with the TE. Due to the high mobility of Graphene, the ions move laterally to form sp2 bonding with the Graphene surface. During the OFF state, negative voltage is applied to the TE, pushing the ions back into the oxide bulk. The high electric field is able to overcome the energy of sp2 bonding, freeing the ions from Graphene. The ions recombine with the oxygen vacancies to form a neutral oxide. During this cycle and coupled with Joule heating, the CF becomes disconnected, giving rise to the high resistance state of the device.



8.2.5 MEH-PPV: ZnO nanocomposite thin film for OLEDs application

Incorporating inorganic nanostructures into organic optoelectronic devices has been growing in the past few years. The instability of organic material is an important issue faced by the organic device caused by the degradation and low conductivity due to high operating voltage of OLEDs device. In this research, nanocomposite organic-inorganic thin film was studied by incorporating ZnO nanotetrapods in MEH-PPV solutions. The growth of the ZnO nanotetrapods has been studied in order to synthesis uniform ZnO nanotetrapods by varying its evaporation temperature and gas flow rate using double furnace thermal chemical vapor deposition (CVD) method. It can be seen that the ZnO nanotetrapods has good electrical properties that can transport the electron efficiently in the nanocomposites thin film. The deposition of ZnO nanotetrapods has been embedded into the MEH-PPV polymer matrix. Furthermore, the optimum parameter for ZnO nanotetrapods and MEH-PPV deposition was selected and used to fabricate MEH-PPV: ZnO nanocomposites thin film using the spin coating method. This condition was achieved by preparing ZnO nanotetrapods weight composition of 0.2 wt% in MEH-PPV solutions that produced a smaller length of ZnO nanotetrapods (~600 nm) and highest conductivity 7.40 x 10^{-1} S. cm^{-1}. The ZnO weight composition of 0.2 wt% showed highest visible emission due to high energy transfer from particle to the polymer. The MEH-PPV: ZnO nanocomposites thin film improved the performance of electrical properties compared to a single layer of MEH-PPV thin film for OLEDs application.



8.2.6 Nanocomposite P3HT: Graphene thin film for organic solar cell applications; TiO_2 thin film for optical sensor; SnO2thin film for water quality sensor

Our group carried several studies involving oxide material and carbon material with polymer by sol-gel dip coating technique and spin coating technique respectively. On the part for graphene and P3HT polymer, the studies investigates the performance of P3HT:Graphene nanocomposite thin film. The active layer was than being used in organic solar cells. The main work done was to increase the electron mobility. Low electron mobility is recognizing as the main factor that contribute to low efficiency organic solar cells. Therefore, the scope of this research is mainly to improve the photocurrent by increasing the electron mobility. Hall effect measurements has been done and proves that electron mobility increases in P3HT:Graphene nanocomposite. The current also improves as the electron mobility improves. Meanwhile, we also did research on TiO_2 as the sensing membrane in optical sensor. The main scope of TiO_2 as the sensing membrane focus on the application to study the oil quality where we got to know whether the used cooking oil is a new or a recycle cooking oil. This can be monitor by analyzing the wavelength shifting using UV-Visible spectrometer. Besides that, we also have group using SnO_2 to check the water quality. The water quality involves whether the water contains more chlorine and rusk. The sample of water is only from domestic water. The reason why we are doing this research due to now we have low water quality level and the installation of filter is quite expensive. All these researches (organic solar cells, optical sensor and water quality sensor) done are expected to give benefit to human kind.

Name of RIG	NANO-ELECTRONIC (NET) RESEARCH GROUP (Nano-elctronic NETRG)
Leader	Dr. Mohamad Hafiz bin Mamat
Tier	5
RIG Code	CoRe89/T5/2015(24)/FMIA(13)
Registration Year (Senate Approval)	2015
UiTM Niche Area	Advanced Manufacturing & Automation
RIG Niche Area	Nanoelectronics Research on nanoelectronics, nanofabrication, and advanced electronic nanomaterials .

8.3 Group Information and Background of Members

Dr. Mohamad Hafiz bin Mamat
Faculty of Electrical Engineering
Expertise:
Nanosensor, solar cell, nofabrication

Dr. Ahmad Sabirin bin Zoolfakar
Faculty of Electrical Engineering
Expertise:
Sensor, Nanotechnology, Solar Cells, Memristor

Dr. Zurita Binti Zulkifli
Faculty of Electrical Engineering
Expertise:
ransparent and conductive thin film for FED graphene hybrid devices

Dr. Shafinaz Sobihana Bt Shariffudin
Faculty of Electrical Engineering
Expertise:
Organic LED, Thin Film, Fabrications Nanoelectronics

Dr. Puteri Sarah Mohamad Saad
Faculty of Electrical Engineering
Expertise:
Nanotechnology, Optoelectronic Devices. Organic Solar Cells

Mrs. Norulhuda Abd Rasheid
Faculty of Electrical Engineering
Expertise:
Solar cell

Mr. Uzer Mohd. Noor
Faculty of Electrical Engineering
Expertise:
Optoelectronics material and Devices

Dr. Mohamad Fariz Bin Mohamad Taib
Faculty of Electrical Engineering
Expertise:
Nanomaterial Computational Analysis

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7. NEA Azhar, AK Shafura, IHH Affendi, SS Shariffudin, I Saurdi, “ Investigation of electrical and optical properties of MEH-PPV: ZnO nanocomposite films for OLED applications”, AIP Conference Proceedings 1733 (1), 2016

9.0

FRACTURE MECHANIC & MATERIALS INTEGRITY RESEARCH

Aidah Jumahat, Zuraidah Salleh, Anizah Kalam, Koay Mei Hyie, Nik Rozlin Nik Mohd Masdek, Mardziah Che Murad, Shahriman Zainal Abidin

9.1 Introduction

Fracture Mechanics and Materials Integrity research group is formed to foster research on behavior, deformation, damage and failure of engineering materials when subjected to various types of loading and conditions.

Many activities emphasize on the following areas:

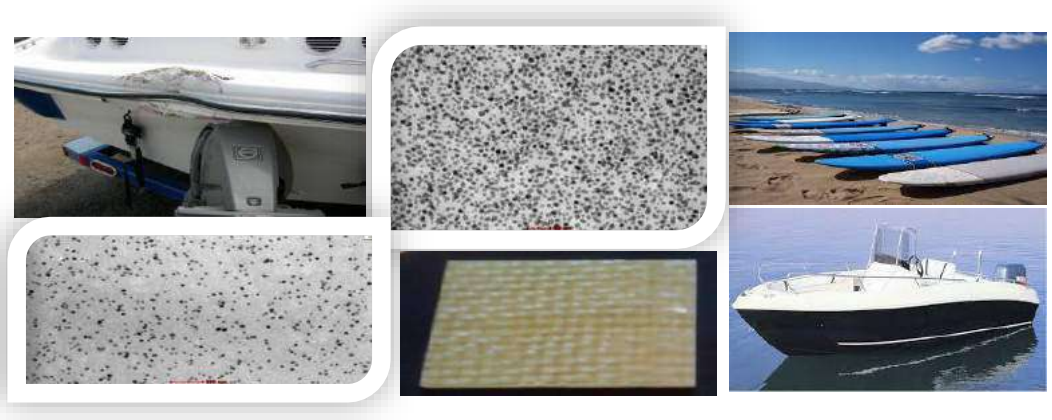
1. Design and analysis of mechanical structures and machine elements based on experimental, mathematical modeling and simulation
2. Development of new materials, high-strength light-weight components and structures
3. Integration of materials properties and their applications in real engineering and manufacturing industries including automotive, railway, aerospace and marine

Knowledge and technology transfer to clients includes guidelines, software, action plans, problem solving and industrial designs.

9.2 Research Highlights

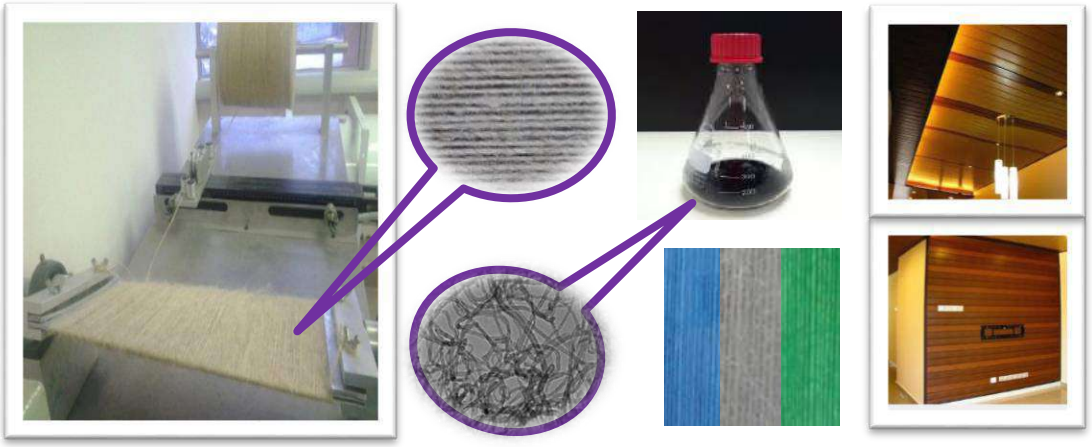
9.2.1 Fibre Nano-Hybrid

Damage resistance and tolerance of fibre reinforced polymer (FRP) composites is one of the most important properties to be considered during structural design process. In this research, a new composite material consists of glass fibre was hybridized with Kevlar fibre as reinforcement materials. The matrix epoxy resin system was modified by incorporating nanosilica into the resin system. Combination of glass fibre and Kevlar fibre produces a good impact resistance, high strength and lightweight materials. In future, this new composite material will be used in marine application such as boat hull which this application requires high damage resistance and tolerance properties.



9.2.2 Carbon Nanotubes Coat Kenaf ECO-FRIENDLY Composites

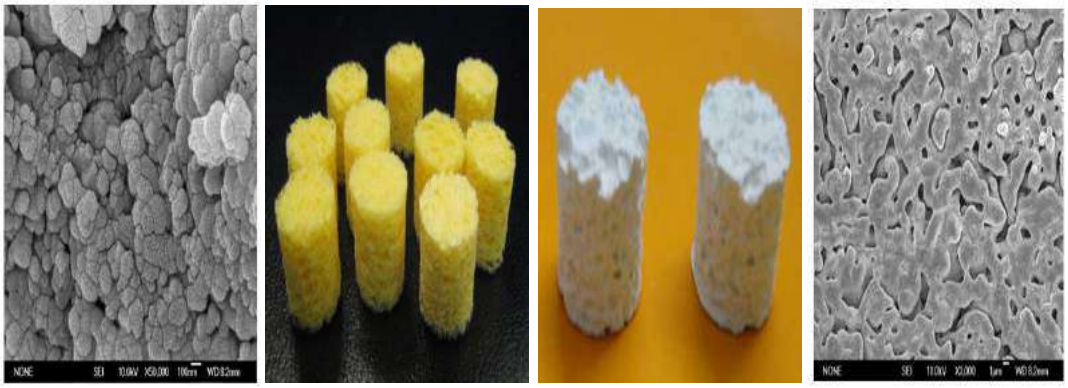
Due to environmental awareness and sustainability concept, kenaf fibre has been considered as reinforcement in polymer based composites. However, kenaf fibre possesses low mechanical and high moisture absorption properties. This limits its usage to low stress application and secondary structures only. Therefore, the modification of matrix by incorporating carbon nanotube (CNT) is an effective way to overcome this problem. In future, this new composite material will be used in buildings and constructions application.



9.2.3 Porous Strontium Doped Hydroxyapatite (SrHA)

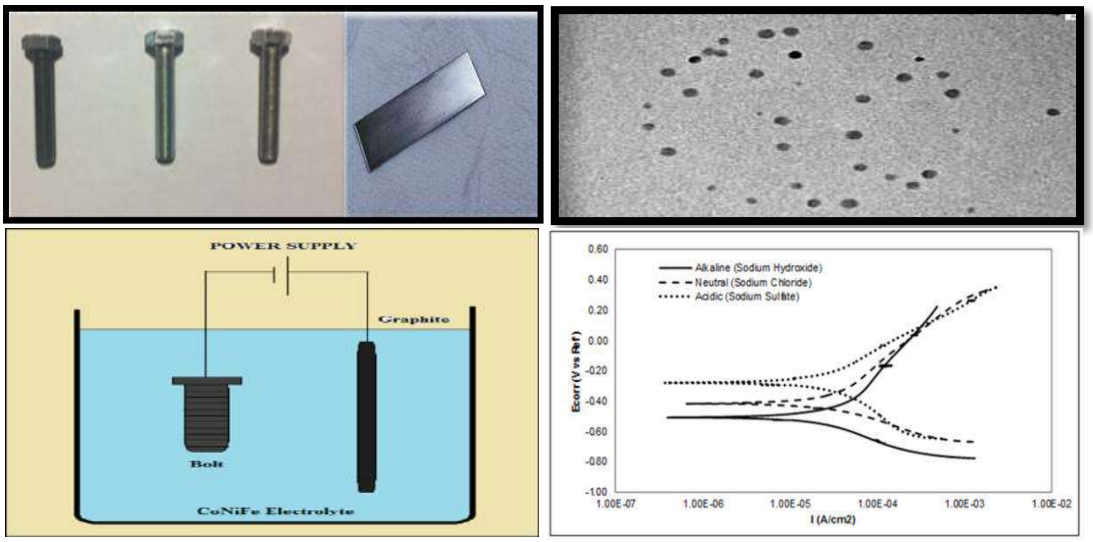
For tissue regeneration in medicine, three-dimensional scaffolds with specific characteristics are required. These scaffolds are expected to have good interconnection between pores, biocompatible and controllable degradation rate to promote bone ingrowth and to support bone-cell attachment. In this study, strontium doped hydroxyapatite (SrHA) porous bodies were fabricated by using polymeric sponge method. Polymeric sponge was chosen as a porous template because it owns the characteristic of partly hydrophilic which allows it to adhere with water based slurry which contains SrHA. To prepare the porous samples, the synthesized SrHA nanopowders were mixed with distilled water and appropriate amount of

dispersing agent followed by drying in the ambient air and sintering at 1300°C. Morphological evaluations by FESEM measurement revealed that the SrHA scaffolds were characterized by macro-micro interconnected porosity, which replicates the morphology of the cancellous bone.



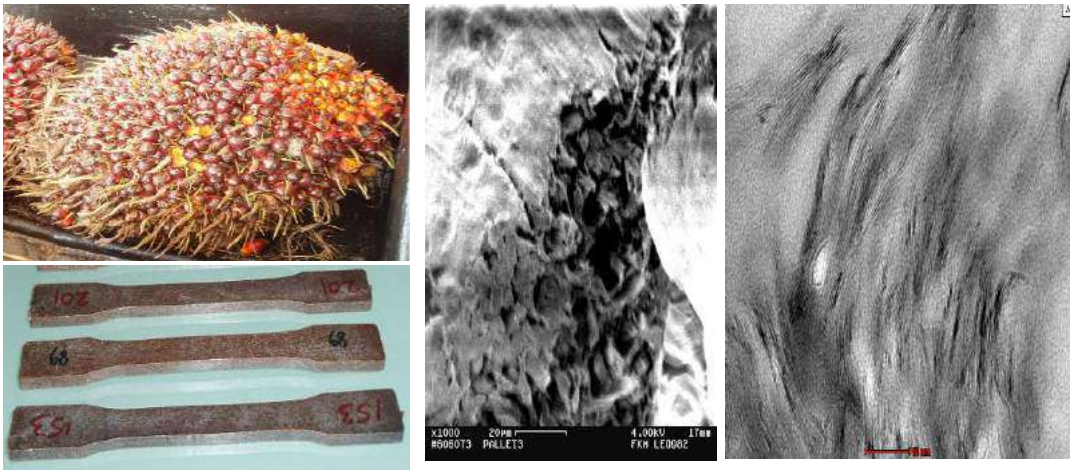
9.2.4 Co-Ni-Fe coated steel

Coating is one of the economic and long lasting solutions to protect the steel from corrosion. Coating can improve the lifetime of the material by two to ten times if compared to original material. The objective of this project is to coat steel with Co-Ni-Fe nanocoating using electrodeposition method. Corrosion and wear testing were carried out revealing good performances of Co-Ni-Fe coated steel. The corrosion rate is less than 0.003 mm per year. The wear loss of coating is less than 5% after 12 hours slurry wear test. Hence, the new Co-Ni-Fe nano-coating has the potential to replace the established chromium coating as a green and non-toxic corrosion protection layer. The Co-Ni-Fe coated steel has been proposed for potential application in bolt, coupling and wear resistant parts and suitable to be used in alkaline environment. The Co-Ni-Fe coating can be applied in all industries using steel parts even at high temperature environment. The benefit of Co-Ni-Fe coating is to enhance the corrosion and wear protection thus prolong the lifespan of the steel parts.



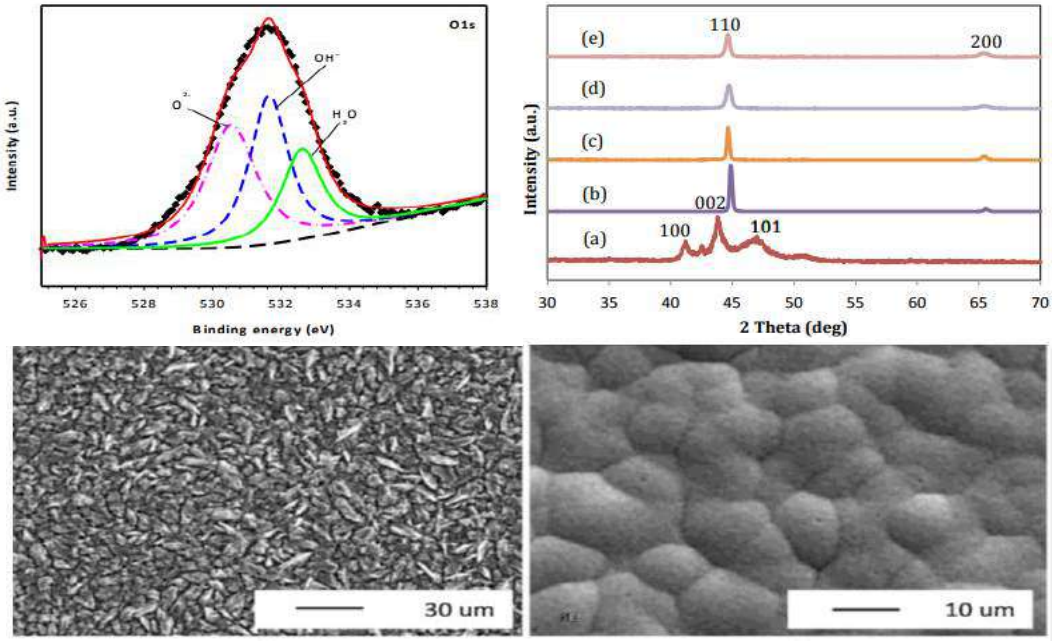
9.2.5 Clay modified- Oil Palm Fruit Bunch (OPFB) Composite

Natural fibres have attracted the interest of material scientists, researchers, and industries because of their specific advantages as compared to conventional or synthetic fibres to be used as reinforcement or filler in composites. Several attempts have been successfully done to enhance the mechanical properties by treating the fibres to improve the bonding. This research investigates the use of clay polymer nanocomposites as the matrix to improve the mechanical properties of OPFB composites, besides the adoption of fibre treatment.



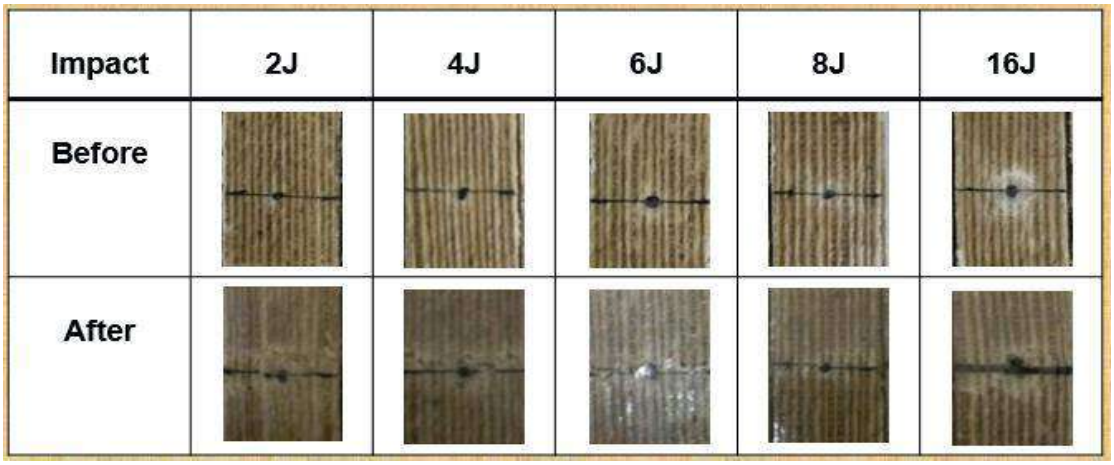
9.2.6 Nanocystalline Cobalt-Iron (CoFe) Alloys Coating

Nanocrystalline materials with grain sizes less than 100 nm, have attracted considerable attention due to their enhanced properties as compared to their polycrystalline counterparts. However, investigation on the corrosion resistance of these materials is still lacking. In order to further expand their future applications, their corrosion behaviour is of great importance. Hence, in this study, nanocrystalline Co and CoFe alloy coatings were prepared through the electrodeposition process and their electrochemical corrosion behaviour were investigated. Depending on the environment, the effect of the nanocrystaline grain sizes as well as Fe alloying resulted in different corrosion responses. A decrease in grain size was observed with an increase in iron concentration that also leads to a change in crystal structure from HCP to BCC phase structure. In This study, the corrosion properties of these electrodeposited nanocrystalline Co and CoFe alloy coatings were also studied in solutions ranging from acidic to alkaline.



9.2.7 Hybrid Natural-Synthetic Fibres Composites

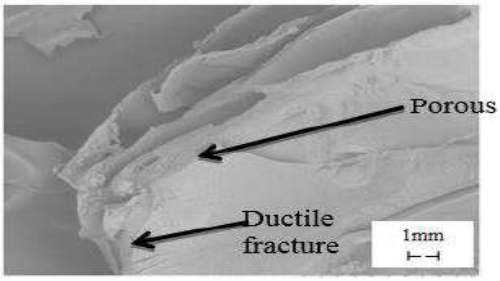
Hybridization of natural long kenaf fibre with woven fibreglass provides an alternative way to reduce the usage of non-renewable and toxicity man-made synthetic fibres. Besides that, the advantages of kenaf fibre that are environmental friendly, low cost, light weight and high availability in Malaysia can be used as one of great reinforcement material for this hybrid composite. Therefore, this study involved investigation of impact resistance of this hybrid composites with unsaturated polyester matrix resin through special built falling weight test.

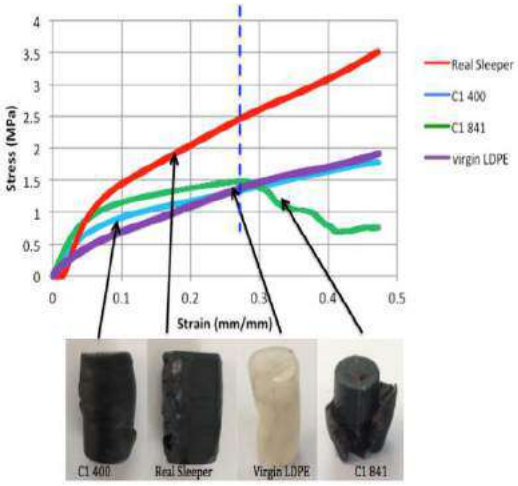


9.2.8 Kenaf Composite Material For Railway Sleeper Application

Railway transportation is one of the public transports that are mainly being used in Malaysia. Thus, the need of railways is also increased to meet the target. A railway sleeper is a rectangular support for the rails in railroad tracks. The sleeper used now is shipped from the KLP Company based in Netherlands. Since Malaysia currently does not produce enough sleepers, the government needs to import the sleeper from

the other country. In this project, a new composite based on natural fibres has been developed as alternative materials to produce railway sleeper.





9.3 Group Information and Background of Members

Name of RIG	Fracture Mechanics & Materials Integrity (FMMI)
Leader	Assoc. Prof. Dr. Aidah Jumahat
Tier	5
RIG Code	CoRe108/T5/2016(13)/FMIA(17)
Registration Year (Senate Approval)	2016
UiTM Niche Area	Advanced Manufacturing & Automation
RIG Niche Area	Materials Integrity & Failure Analysis Research on integrity and failure mechanisms of advanced materials subjected to various types of loadings and conditions.

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10.0

BIOMECHANICAL & CLINICAL ENGINEERING (BIOMEC)

Jamaluddin Bin Mahmud, Soleuddin Bin Shuib, Muhammad Fairuz Bin Azmi, Mohd Afzan Bin Mohd Anuar, Addul Halim Bin Addullah, Nor Fazli Bin Abdull Manan, Sharul Hiyam Bin Marwan

10.1 Introduction

Biomechanical and Clinical Engineering is formed to encourage multidisciplinary research on mechanical engineering and medical physics. The research activities involve mechanical/clinical testing, analytical equations, modeling and computer simulation, and also development of medical support prototype and components. This section also integrates the perspectives of applied mechanics and materials science to solve practical and biomechanics problems based on clinical experiences and industrial demands.

Many activities call attention on the following areas:

- Development of new design of medical support components which minimized the shortcomings as identified by surgeons and medical physician.
- Synthesis, processing, fabrication, machining, testing and modeling of engineering materials and medical support components
- Integration of engineering design and potential medical applications.
- Knowledge and technology transfer to researchers and clients includes guidelines, software, problem solving and innovation of design.

10.2 Research Highlights

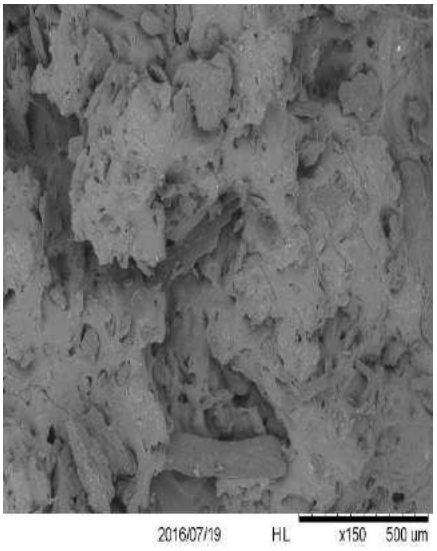
10.2.1 Development of a low cost portable motion capture-analysis system for modified RULA (MRULA)

Computer is now one of the common office tools associated with daily job activities. The usage of computer for a long period and with poor postures would cause several upper limb disorders. **Upper limb disorders (ULDs)** can be defined generally as injuries or disorders that affect the human body and musculoskeletal system. It has been a significant and costly health problems among the working population during the past decades. One of ergonomic approach is using survey method to evaluate the level of ergonomic risk by observation of participants' posture while they were working. Several survey methods such as the **Rapid Upper Limb Assessment** (RULA). **Rapid Entire Body Assessment** (REBA), and **Rapid Office Strain Assessment** (ROSA).RULA then has undergone modification for the computer use only, called RULA for computer use (mRULA. The research objective is to assemble a simple and low cost motion capture-analysis system prototype with reasonable accuracy (FJ Sense) by integrating Kinect and MATLAB.

Infra-red Motion Capture System (VICON)

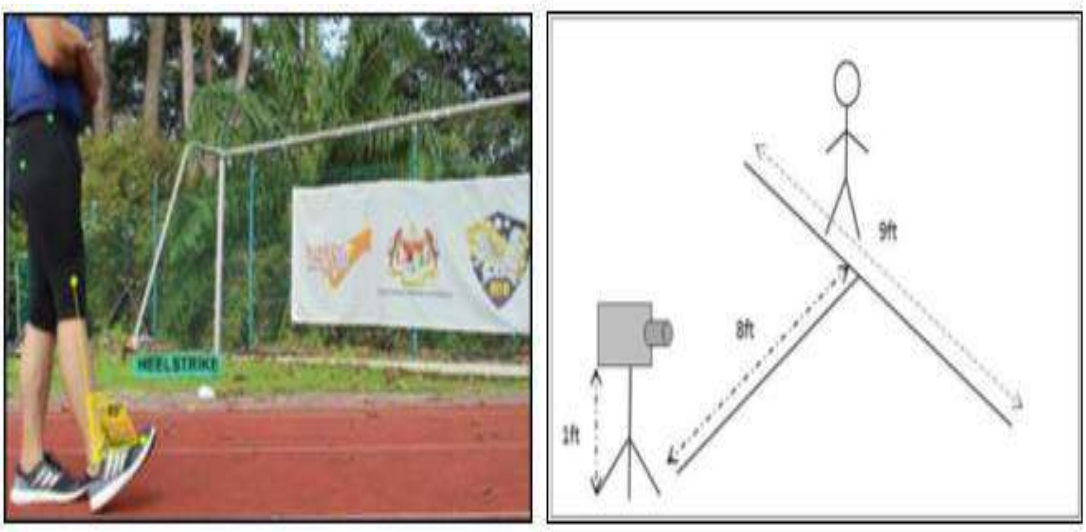
10.2.2 APSil: Arenga Pinnata-Silicone BioComposites

Due to increase awareness on environmental issues especially global warming that leads to rapid melting of ice in the Arctic, researches on seeking alternatives to replace man-made fibres in composite materials have been rapidly discovered. Therefore, the project introduces the employment of natural fibres called Arenga pinnata (Figure 1) as the filler in silicone rubber (Figure 2). The purpose of adding filler in silicone rubber benefits in terms of the stiffness property. Besides that, compare to synthetic fibres, natural fibres can be obtained at a very low cost with low density. They are also abundant in nature which made them easy to be obtained. This material is now readily used and for sale. Nevertheless, the project is still on-going for the long-term aim, which is to seek its ability in sealing and cushioning applications specifically in marine, heavy industries and medical sectors.



10.2.3 Measuring Ankle Angle and Analysis of Walking Gait using Kinovea

Understanding the biomechanics of motion related to human walking gait is important in the area of rehabilitation. Infrared cameras motion capture systems have been widely used. Nevertheless, the system is very expensive and thus alternative solutions are explored. This study is aimed to measure the angle of ankle, knee and hip during walking and then assess the reliabilty of Kinovea in analysing walking gait.



10.3 Group Information and Background of Members

Name of RIG	Biomechanical & Clinical Engineering (BioMeC)
Leader	Assoc. Prof. Ir. Dr. Jamaluddin Mahmud
Tier	5
RIG Code	CoRe125/T5/2016 (30)/FMIA(20)
Registration Year (Senate Approval)	2016
UiTM Niche Area	Advanced Manufacturing & Automation
RIG Niche Area	Research on Biomechanics, Clinical Engineering, behavior, deformation, damage and failure of bioengineering materials and manufacturing products

References

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11.0

HYBRID NANOMATERIALS, INTERFACES & SIMULATION

Nor Aida Zubir, Rasyidah Alrozi, Ahmad Zia Ul-Saufie Mohamad Japeri, Alhan Farhanah Abdul Rahim, Atikah Kadri, Norhaslinda Nasuha, Hawaiah Imam Maarof @ L.Maarof, Faraziehan Senusi And Dr Chang Siu Hua

11.1 Introduction

Hybrid Nanomaterials, Interfaces & Simulation (HYMFAST) research group is formed to foster research and simulation on the development of hybrid nanomaterials towards sustainable environment and energy.

Activities are emphasize on the following areas:

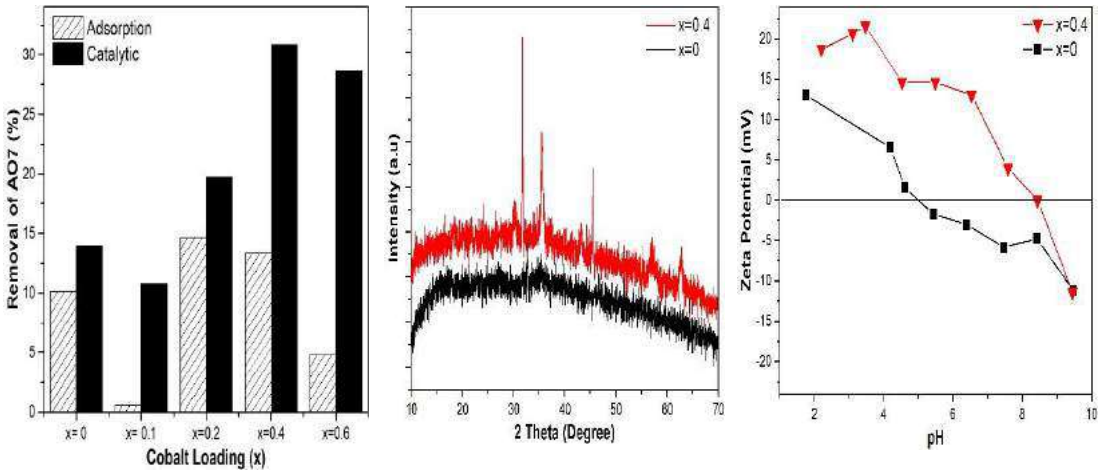
1. Development of new hybrid nanomaterials and its applications towards sustainable environment and energy.
2. In depth fundamental studies of hybrid nanomaterials properties which underlying its behavioral applications.

Modeling the prediction of nanomaterials properties as well as its performance within the domain of framework.

11.2 Research Highlights

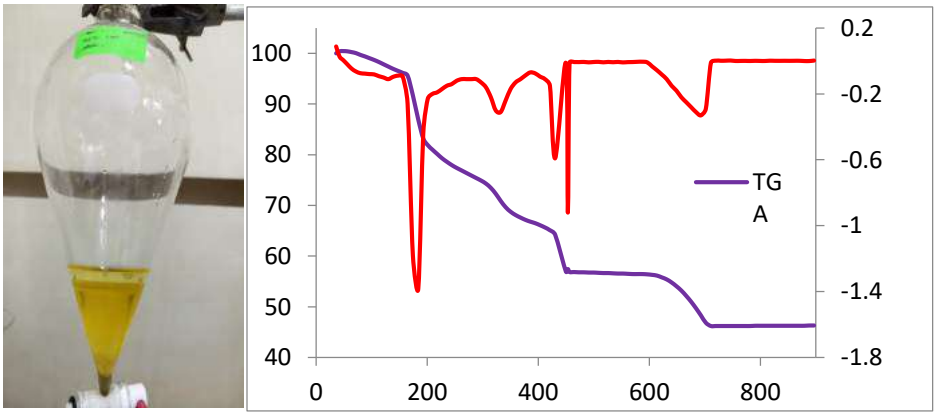
11.2.1 Hybrid nanocatalyst: isomorphic substitution of transition metals into magnetite structure

Oxidation using heterogeneous Fenton and/ or Fenton like reaction has been proven as promising and efficient treatment method for dye degradation by using iron oxide (magnetite) catalyst and hydrogen peroxide as an oxidant. The limitation of this treatment is the lack of recyclability of magnetite as this catalyst continuously loses its activity after a few reaction cycles, thus requiring the addition of a fresh catalyst. Thus, several transition metal cations have been isomorphically substituted into the magnetite structure to enhance its long term catalytic activity as well as its stability. However, details investigation on the synergistic interactions between the substituted metals and the Fe cations in the magnetite structure, which influences the overall catalytic activity, remains unaddressed. Hence, details understanding in these synergistic interactions is crucial towards an establishment of the plausible thermodynamically favourable redox pairs and properties during the catalysis. The objective of this work is to determine the synergistic interaction between the substituted transition metals with Fe cations through the oxidative degradation of dye in the heterogeneous Fenton like reaction as well as the resultant material characterizations



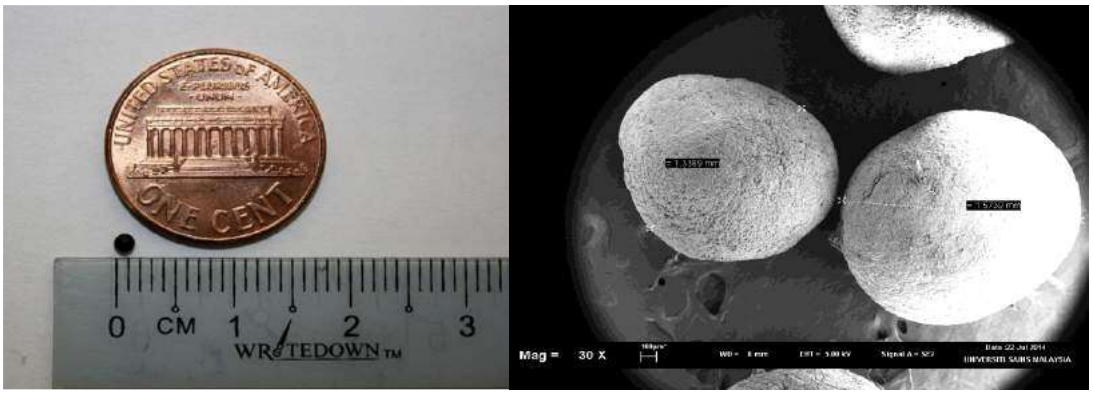
11.2.2 CAO nanocatalysts doped with transition metals in transesterification reaction of palm oil

Depletion of fossil fuel sources in a few decades due to industrialization and motorization has led to a keen interest in the production of alternative fuels like biodiesel. In relation with that, research on the development and improvement of more efficient transesterification process for biodiesel production has great attention in the last decade. As a basic heterogeneous catalyst, CaO has been examined in the transesterification of vegetable oils for biodiesel production due to its lower cost production and high catalytic performance reasons. In this research, calcium oxide (CaO-X) catalysts were prepared by sol-gel method at different Ca^{2+} reactant concentration (X = 1.0, 1.5, 2.0 M). All the synthesized catalysts were then applied to transesterification reaction of palm oil to produce biodiesel. It was also found that CaO-2.0 has high catalytic activity wherein 81% of FAME yield was obtained within 3h reaction.



11.2.3 Hybrid nanoparticles augmented polymeric microcapsules

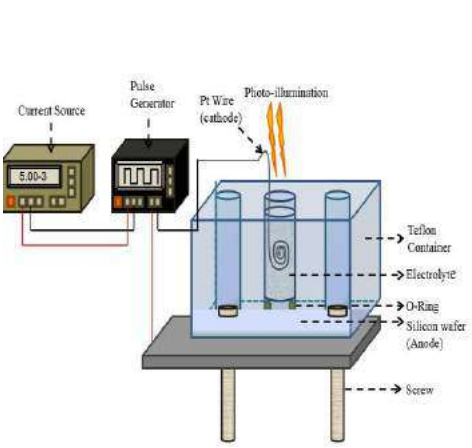
Microcapsule has remarkable advantages in engineering application for pollutants removal and biomedical field for transportation. It has obviously drawn attention from the research community. In environmental engineering application, microcapsules could serve as encapsulation agent of nanoparticles (NPs) to drastically reduce the risk associated to nano-toxicity when it is indirect contact with surroundings. Even though magnetic responsiveness of capsules can be used for ease of separation, one of the constraints is that the encapsulated particles will restrict the performance of capsules materials in pollutants removal. Therefore, tuning morphology of the microcapsules could be crucial to further enhance the performance of pollutant removal efficiency. Hence, this work primarily focuses on tuning morphology of the magnetic nanoparticles-polymeric microcapsules via various physical properties. The fundamental understanding at the interfaces and its mass transport properties is simulated using physics simulation software in order to understand the phenomenon well. Feasibility study using synthetic dyes as the representable model system for degradation indicates magnetic nanoparticles augmented microcapsules could be a viable option to degrade dye pollutant effectively.

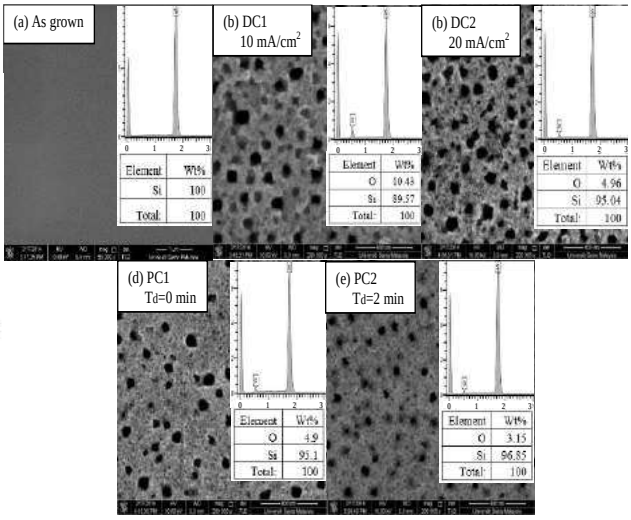


11.2.4 Novel Integrated Pulsed Electrochemical Etching of Porous Si and porous GaN for Potential Optoelectronics Application

Porous silicon (PS) attracted many attention for optoelectronic device since the discovery of its efficient visible room temperature photoluminescence (PL). The sensitivity of PS depends upon the morphological characteristics of pores, which is the diameter of the pores, its surface uniformity and the thickness of the layer. The changes on the porous surfaces can subsequently alter the electrical and optical characteristics of porous semiconductors. Electrochemical etching is a simple technique for fabrication of pores on the surface of silicon. To optimize the surface characteristics of porous layer, parameters involved are current density, time etching, shape of the current and electrolyte used. However, the challenge faced in obtaining a stable current and a stable current-based etching process suffered from the formation of hydrogen bubbles in pores while decreasing the speed of etching and resulted in shallow pores formation. To overcome this problem, the pulse current method has been introduced by applying the discontinuous current with combination

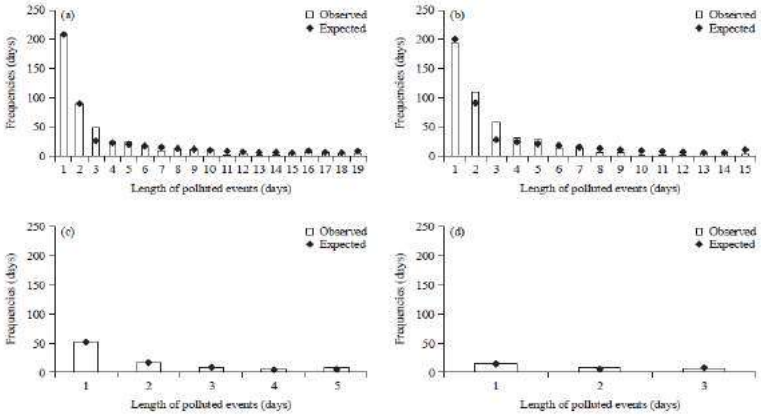
of cycle time (T) and pause time (T_off) in order to decline the hydrogen bubbles and allow HF react with substrate. In this project, the porous silicon were fabricated by using pulse etching technique. The pause time (T_off) has a significant effect on the size of pores and porosity formation which can improve the porosity.





11.2.5 Air Pollution Modelling In Malaysia

Air pollution is poisonous gases and trapped particles that come from primary and secondary pollutants. Primary pollutant is a natural source of pollution that happen directly from natural disasters such as earthquakes, while secondary pollutant is a man-made pollution as a result from the haze, open burning and exhaust fumes from motor vehicles. Due to the factors that trigger air pollution, the level of air pollution concentrations needs to be modelled with several predictors in order to predict the level of air pollutant concentrations for the next few days. The multiple linear regression model developed by past researchers is by the method of ordinary least square (OLS) where this method includes the influential outliers. In other words, OLS method is sensitive to the outliers and would lead to an incorrect information of air pollution in Malaysia. The aim of this study is to develop model with reduce influential of outlier (extreme event) and to predict future air pollution concentrations level in selected area in. Various method were used in this study i.e. statistical models, machine learning approach and a new approach in hybrid models. The models were useful in helping authorities to actuate air pollution impact preventative measures in Malaysia.



11.3 Group Information and Background of Members

Name of RIG	Hybrid Nanomaterials, Interfaces & Simulation (HYMFAST)
Leader	Dr Nor Aida Zubir
Tier	5
RIG Code	CoRe144/T5/2017(4)/FMIA(23)
Registration Year (Senate Approval)	2017
UiTM Niche Area	Chemical & Advanced Materials
RIG Niche Area	Research & simulation of hybrid nanomaterials towards sustainable environment and energy.

Dr Nor Aida Zubir
Faculty of Chemical Engineering
Expertise:
Nanocomposites, Heteregenous Catalyst, Fenton

Rasyidah Alrozi
Faculty of Chemical Engineering
Expertise:
Adsorption, Separation processes

DR. Ahmad Zia Ul-saufie Mohamad Japeri
JSKM
Expertise:
Modelling, Statistical Analysis, Air Pollution

Dr Atikah Kadri
Faculty of Chemical Engineering
Expertise:
Heteregenous Catalyst, MOF, Energy storage

Dr. Alhan Farhanah Abdul Rahim
Faculty of Electrical Engineering
Expertise:
Nanomaterials for electrochemical,photonics & sensing application

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12.0

ULTRASONIC OF NOVEL METALS AND OXIDES RESEARCH

Norazila Ibrahim, Ahmad Kamal Hayati Yahya, Rosdiyana Hisam, Zakiah Mohamed, Shafinaz Sobihana Shariffudin, Syafawati Nadiah Mohamed And Ahmad Taufek Abdul Rahman

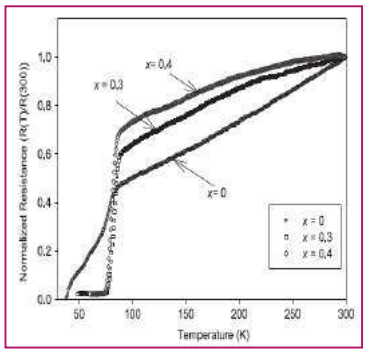
12.1 Introduction

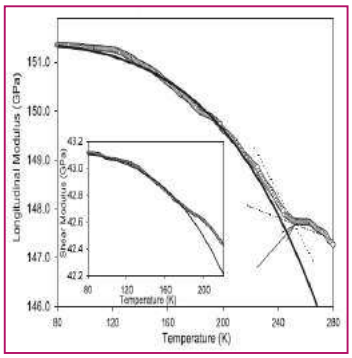
The Ultrasonics of Novel Metals and Oxides (UNMOX) research interest group (RIG) was established in 2014 under the Faculty of Applied Sciences and is registered with the Research and Management Institute (RMI). UNMOX aims to be amongst the country's leading group in elastic and structural properties of novel oxides such as superconducting and magnetic polycrystalline and amorphous oxides. The group also conducts research on other complementary physical properties of the oxides such as electrical, optical and structural properties of oxides relevant for practical applications. Currently our independent researchers are in collaboration with other leading local and overseas groups and laboratories.

12.2 Research Highlights

12.2.1 Effects of Cd^{2+} substitution on elastic properties and step-like anomalies in $Tl_{0.9}Bi_{0.1}Sr_{1.8}Yb_{0.2}Ca_{1-x}Cd_xCu_{1.99}Fe_{0.01}O_{7-\delta}$ superconductors

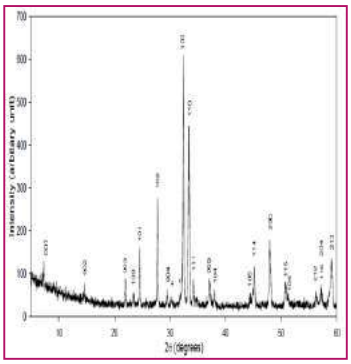
Cd-doped $Tl_{0.9}Bi_{0.1}Sr_{1.8}Yb_{0.2}Ca_{1-x}Cd_xCu_{1.99}Fe_{0.01}O_{7-\delta}$ (x = 0–0.4) bulk superconductor samples were prepared by solid-state reaction method,to examine the effect of Cd on ultrasonic velocity and elastic behavior of the samples. The samples were characterized by X-ray diffraction, DC electrical resistivity and temperature dependent ultrasonic velocity measurements. DC electrical resistivity measurement showed all the samples exhibit metallic normal-state behavior with the highest Tc zero observed at around 76.4K (x = 0.3). Ultrasonic velocity measurements at 80K showed a non-linear increase in both absolute longitudinal and shear velocities as well as elastic moduli with Cd substitution with the largest increase observed for the x = 0.3 sample. Temperature dependent longitudinal modulus showed elastic anomaly characterized by a step-like slope change at around 230K for x = 0 & x = 0.3 and at around 250K for x = 0.4 with the x = 0.3 sample showing the sharpest slope change. A comparison between experimental data and calculated lattice anharmonicity curve based on the model proposed by Lakkad, showed large deviation of the experimental longitudinal modulus curves for (x = 0.3) from the calculated anharmonicity curves indicating that the elastic behavior was strongly influenced by the existence of the step-like longitudinal anomaly. On the other hand, our analysis using the Landau free energy model found that the anomalous step-like elastic behavior fitted well with the equation derived from the model for regions below and above the elastic anomaly temperature, T_A. The fitting indicated that the anomaly is related to a phase transition that is suggested to involve ordering of oxygen which introduces strain in the system.

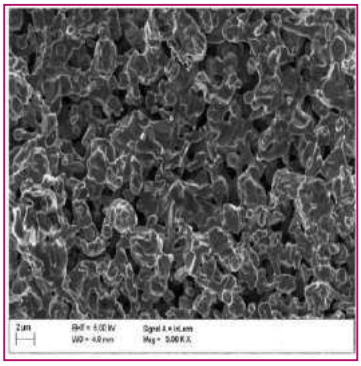


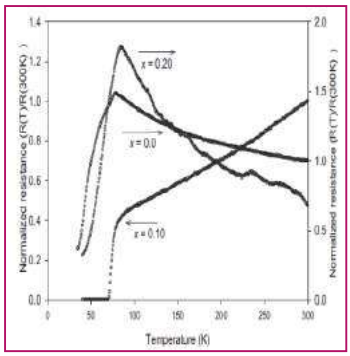


12.2.2 Elastic moduli and step-like elastic anomalies in Ce-substituted $Tl_{0.9}Bi_{0.1}Sr_{2-x}Ce_xCa_{0.9}Y_{0.1}Cu_{1.99}Fe_{0.01}O_{7-\delta}$ (x = 0–0.20) superconductors

Ultrasonic velocity measurements have been performed on polycrystalline $Tl_{0.9}Bi_{0.1}Sr_{2-x}Ce_xCa_{0.9}Y_{0.1}Cu_{1.99}Fe_{0.01}O_{7-\delta}$ superconductor to study the influence of Ce substitution on elastic properties of the samples. Ce was observed to influence elastic moduli at 80 K which showed the largest value obtained at x = 0.10 where, coincidentally, the highest superconducting temperature T_c among samples was also shown. A longitudinal velocity anomaly was observed at around 260 K for the unsubstituted sample (x = 0). Ce substitution caused the temperature of the elastic anomaly to shift to 250 K (x = 0.1) and 262 K (x = 0.2). The existence of the step-like elastic anomaly was suggested to be due to oxygen ordering taking place in Tl-O planes. The analysis of elastic behavior in the vicinity of the elastic anomalies using the Landau free-energy model suggests that the anomaly is due to a phase transition which involves oxygen ordering.



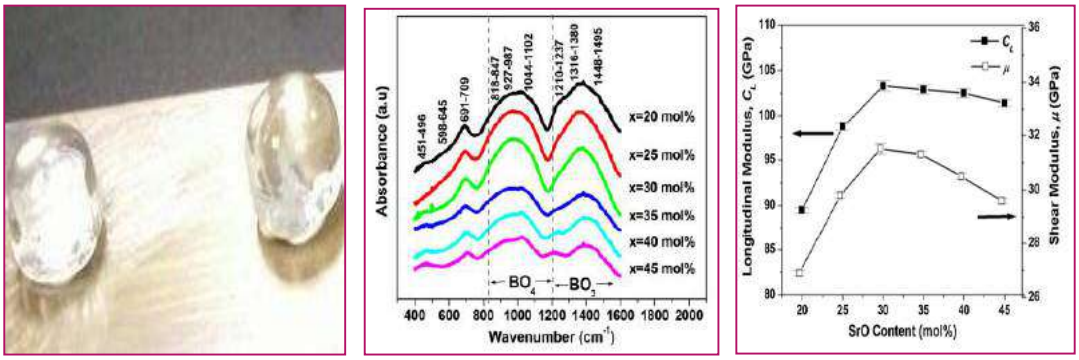




12.2.3 Anomalous elastic behaviour of xSrO-10PbO-(90-x)B_2O_3 glass system

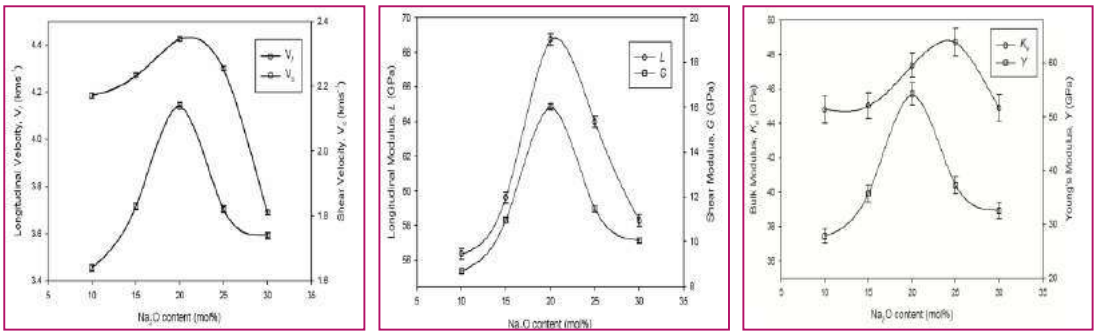
Glass samples with composition xSrO-10PbO-(90-x)B_2O_3 (x = 20, 25, 30, 35, 40 and 45) were prepared by melt-quenching method to elucidate the elastic behaviour due to borate anomaly. Structural investigation of glass samples were carried out by X-ray diffraction (XRD) and Fourier transform infrared (FTIR) spectroscopy while elastic properties were studied by measuring both longitudinal and shear velocities using pulse-echo method at 5 MHz frequency. FTIR analysis revealed the presence of BO_4 and BO_3 vibration groups. Addition of SrO has resulted in increased ultrasonic velocities, elastic moduli (*CL, μ, K* and *Y*), hardness (*H*), Debye temperature (*θD*) for

SrO content up to 30% but decreased for higher SrO addition. The fraction of the four coordinated boron atoms (N_4) values, calculated from FTIR spectra increased for $x \leq$ 30 mol% followed by decrease at $x >$ 30 mol%. Quantitative analysis of ultrasonic data using the bulk compression and ring deformation models showed reduction in the ratio of calculated bulk modulus to the experimental bulk modulus, K_{bc}/K_e for $x \leq$ 30 mol% indicating decreased ring deformation in borate anomaly region.



12.2.4 Effect of increasing concentration of Na_2O on structural, elastic and optical properties of (90 − *x*) GeO_2–*x*Na_2O–10PbO glass system in the germanate anomaly region

Ternary germanate glasses (90 − *x*)GeO_2–*x*Na_2O–10PbO (*x* = 10–30 mol%) have been prepared by the melt-quenching method. Density, ρ increased with Na_2O content up to maxima at 20 mol% while molar volume, V_a showed an opposite trend to the density, with a minima at 20 mol% of Na_2O content indicating the presence of the germanate anomaly. Ultrasonic velocity measurements showed both longitudinal, v_l and shear, v_s velocities increased up to 20 mol% before decreasing with further addition of Na_2O. Independent longitudinal, *L* and shear, *G* moduli along with Young's modulus, *Y*, mean sound velocity, v_m, Debye temperature, θD, and hardness, *H* recorded maximum values at 20 mol% of Na_2O content which were suggested to be related to the germanate anomaly. Structural modification occurring due to conversion of six-membered GeO_4 rings to three-membered rings of GeO_4 changed bond density and compactness of the glass systems and caused the increase in rigidity and stiffness of the glasses. Beyond 20 mol% of Na_2O, the decrease in the elastic moduli was due to depolymerization of the glass network. Meanwhile, optical energy gap, E_{opt} exhibited a minima at 20 mol% whereas Urbach energy, E_U and refractive index, *n* showed a maxima at the same concentration, thereby indicating variation in polarizability due to changes in concentration of bridging and non-bridging oxygen.



12.3 Group Information and Background of Members

Name of RIG	Ultrasonic of Novel Metals and Oxides (UNMOX)
Leader	Dr. Norazila Binti Ibrahim
Tier	5
RIG Code	CoRe31/T5/2014/31/FMIA/5
Registration Year (Senate Approval)	2014
UiTM Niche Area	Applied Sciences
RIG Niche Area	Research on elastic and structural properties of novel oxides such as superconducting and magnetic polycrystalline and amorphous oxides

Prof. Dr. Ahmad Kamal Hayati Yahya

Faculty of Applied Sciences
Expertise: Ultrasound & Superconductor

Dr. Zakiah Mohamed
Faculty of Applied Sciences
Expertise:
Magnetic & Diffraction

Dr. Rosdiana Hasham@Hisam
Faculty of Applied Sciences
Expertise:
Glass & Dielectric

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13.0

CERAMIC GAS AND MAGNETIC SENSOR MATERIALS RESEARCH

Misbah Hassan, Norazila Ibrahim, Suraya Kamil, Mohd Fauzi Maulud, Hafizi Lukman, Mohd Salleh Mohd Deni

13.1 Introduction

Ceramic Gas and Magnetic Sensor Materials Research Group (CGMSM) was set up in 2014 as a new group at Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam and is registered under Research and Management Institute (RMI). Our research focuses on the physical properties of novel perovskite oxide materials such some titanites and manganites which relevant for their potential applications. Our research activities also involve in variation of projects in order to improve the physical properties, the performance of the studied materials as well as to understand the underlying mechanism which may responsible for the observed behaviour of the materials. Our aims are to advance knowledge as well as to enhance research capabilities in order to place our group at the international level in the field of gas sensor and magnetic sensor.

At present, our group involved in the preparation and characterization of novel perovskite materials and the research is divided into two main areas:

1. **Magnetic Sensor element**

   Spintronics which employs spin of charge carriers for determining direction and intensity of currents have been initially used since the discovery of giant magnetoresistance (GMR) phenomena where the resistance changed dramitcally in response to a magnetic field. Spintronic-based manganites is a new class of material under study for future magnetic sensors elements due to its collosal magnetoresistance (CMR), the large drop of the electric resistance when magnetic field is applied, which may increased sensing efficiency. Manganites possess interesting features such as metal-insulator transition accomponied by ferromagnetic-paramagnetic transition, and free electrons are almost completely spin polarized, make these materials are important for spintronic area of research.

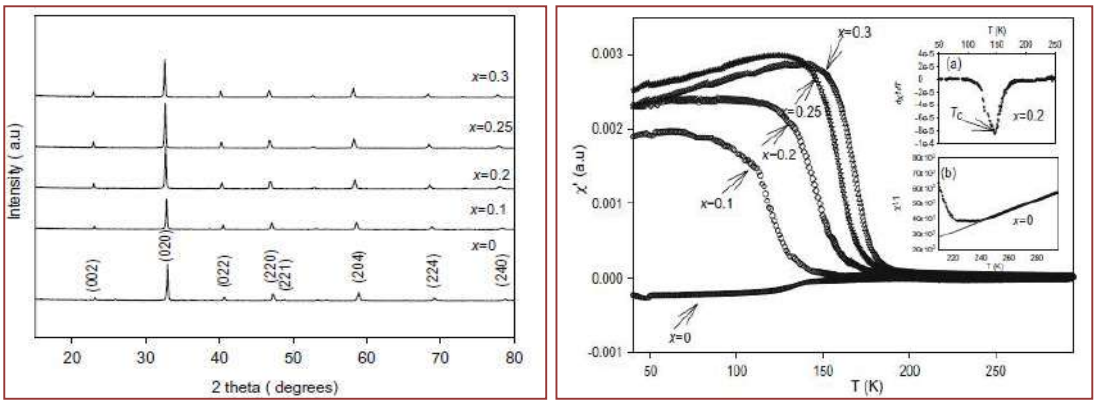
2. Gas Sensor

The mechanism of hot spot formation in the ceramic rods upon application of external voltage has been explained in terms of large joule heating due to large voltage drop as a result of large increase in resistivity. The application of some ceramic rods utilizing the hot spot phenomenon as oxygen sensing elements has also been introduced. At present, further extensive research on oxygen-sensitive hot spot by using novel ceramic materials is being conducted for industrial applications.

13.2 Research Highlights

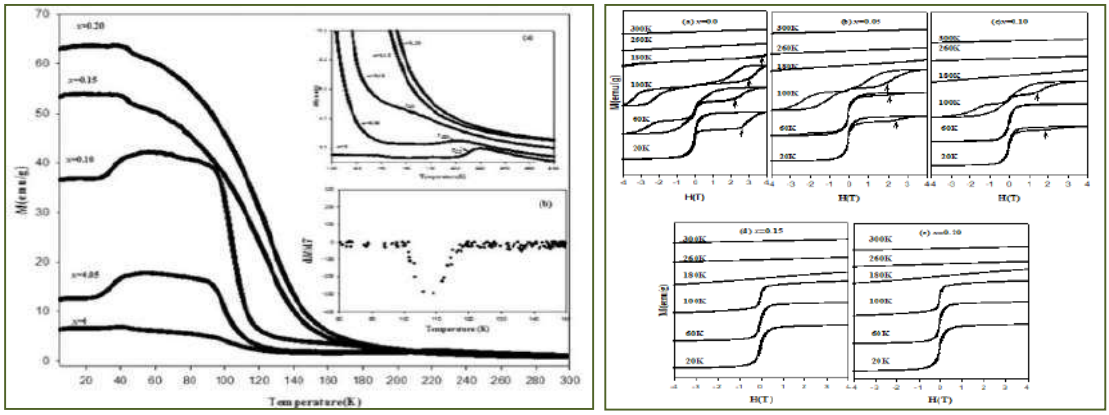
13.2.1 Inducement of Itinerant Electron Transport in Charge-Ordered $Pr_{0.6}Ca_{0.4}MnO_3$ by Ba Doping

The effects of Ba^{2+} doping on the electrical and magnetic properties of charge-ordered $Pr_{0.6}Ca_{0.4}MnO_3$ were investigated through electrical resistivity and AC susceptibility measurements. X-ray diffraction data analysis showed an increase in unit cell volume with increasing Ba^{2+} content indicating the possibility of substituting Ba^{2+} for the Ca-site. Electrical resistivity measurements showed insulating behavior and a resistivity anomaly at around 220 K. This anomaly is attributed to the existence of charge ordering transition temperature, T_{CO} for the x = 0 sample. The Ba-substituted samples exhibited metallic to insulator transition (MI) behavior, with transition temperature, T_{MI}, increasing from ~98 K (x = 0.1) to ~122 K (x = 0.3). AC susceptibility measurements showed ferromagnetic to paramagnetic (FM-PM) transition for Ba-substituted samples with FM-PM transition temperature, T_c, increasing from ~121 K (x = 0.1) to ~170 K (x = 0.3), while for x = 0, an antiferromagnetic to paramagnetic transition behavior with transition temperature, T_N, ~170 K was observed. In addition, inverse susceptibility versus T plot showed a deviation from the Curie–Weiss behavior above T_c, indicating the existence of the Griffiths phase with deviation temperature, TG, increasing from 160 K (x = 0.1) to 206 K (x = 0.3). Magnetoresistance, MR, behavior indicates intrinsic MR mechanism for x = 0.1 which changed to extrinsic MR for x > 0.2 as a result of Ba substitution. The weakening of charge ordering and inducement of ferromagnetic metallic (FMM) state as well as increase in both T_c and T_{MI} are suggested to be related to the increase of tolerance factor τ and increase of e_g−electron bandwidth as average ionic radius at A-site,< r_A > increased with Ba substitution. The substitution may have reduced MnO_6 octahedral distortion and changed the Mn–O–Mn angle which, in turn, promotes itinerancy of charge carrier and enhanced double exchange mechanism. On the other hand, increase in A-site disorder, which is indicated by the increase in σ^2 is suggested to be responsible for the widening of the difference between T_c and T_{MI}.



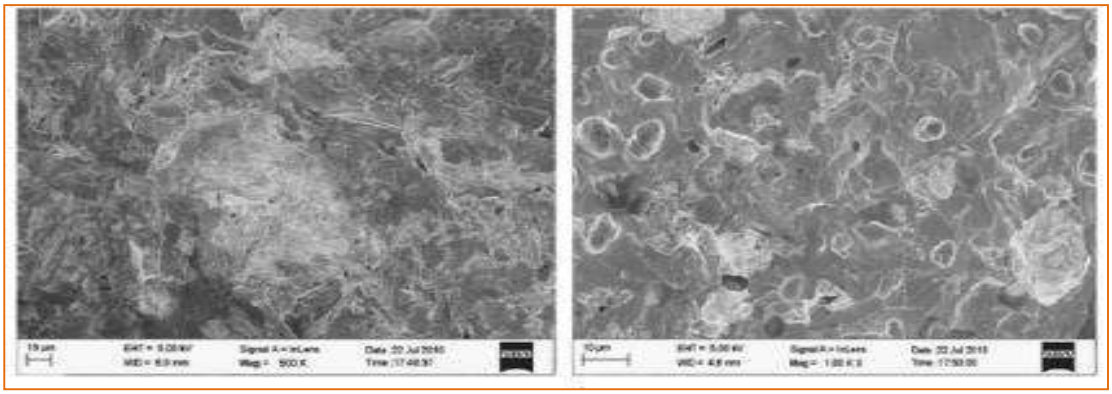
13.2.2. Inducement of ferromagnetic-metallic phase in intermediate-doped Charge-ordered Pr0.75Na0.25MnO3 manganite by K^+ - substitution

Polycrystalline $Pr_{0.75}Na_{0.25-x}K_xMnO_3$ (x = 0, 0.05, 0.10, 0.15 and 0.20) ceramics were prepared using conventional solid-state method and their structural, magnetic and electrical transport properties were investigated. Magnetization versus temperature measurements showed un-substituted sample exhibited paramagnetic 94ehaviour with charge-ordered temperature, T_{CO} around 218 K followed by antiferromagnetic 94ehaviour at transition temperature, T_N ~ 170 K. K^+-substitution initially weakened CO state for x = 0.05–0.10 then successfully suppressed the CO state for x = 0.15–0.20 and inducing ferromagnetic-paramagnetic transition with Curie temperature, T_C increased with x. In addition, deviation of the temperature dependence of inverse magnetic susceptibility curves from the Curie-Weiss law suggests the existence of Griffiths phase-like increased with x. Magnetization versus magnetic field curves show existence of hysteresis loops at T < 260 K (x = 0) and T < 180 K (x = 0.05–0.10), which related to metamagnetic transition occurring at critical field. Electrical resistivity measurements showed an insulating 94ehaviour for x = 0 sample while for x = 0.05–0.20 samples showed metal-insulator transition and transition temperature, T_{MI} increased with x. The increased in T_C and T_{MI} are attributed to the increase in tolerance factor which indicates reduction in MnO_6 octahedral distortion consequently enhanced double exchange interaction.



13.2.3 Effect of divalent ion substitution on oxygen sensing properties of hot-spot based$Eu_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$ and $Eu_{1-y}Mg_yBa_2Cu_3O_{7-\delta}$ ceramics

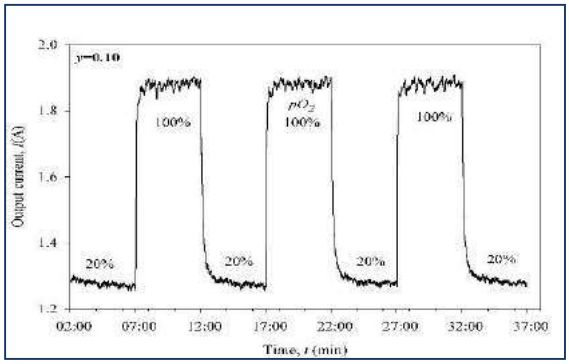
This research study on the effects of Ca and Mg substitution on oxygen sensing properties of hot spot based Eu123 rods are reported. $Eu_{1-x}Ca_xBa_2Cu_3O_{7-\delta}$ (x = 0.2–0.5) and $Eu_{1-y}Mg_yBa_2Cu_3O_{7-\delta}$ (y = 0.2–0.5) ceramics were synthesized from oxide powders using the standard solid state method and fabricated into short rods. For Ca-substituted rods, after appearance of a visible hot spot, a constant current plateau in *I–V* curve was formed. The output current response of the rod in periodically changing pO_2 between 20% and 100% showed improved stability and reproducibility for x = 0.4 compared to x = 0.2. Improved oxygen absorption and desorption time was observed for x = 0.4 compared to previously reported un-substituted rod. On the other hand, for Mg-substituted rods the *I–V* behavior after formation of hot spot showed a negative slope. Faster absorption time of 3.0s and desorption time of 6.9s were observed for y = 0.4 compared to y = 0.2. The improved output current stability, reproducibility and response time is suggested to be due to changes in oxygen activation energy and increased hole concentration as a result of Ca^{2+}/Mg^{2+} substitutions. The Mg-substituted rods showed better performance compared to Ca-substituted rods possibly due to higher porosity and vacancy concentration.

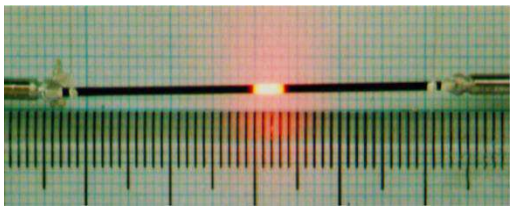


13.2.4 Oxygen sensing behaviour of Pr doped ceramic rods with hot-spot

In this study, $Eu_{1-x}Pr_xBa_2Cu_3O_{7-\delta}$ (x = 0.05, 0.10, and 0.20) ceramic rectangular rods were prepared by the solid-state reaction method to investigate the effect of Pr doping on oxygen sensing behaviours. X-ray powder diffraction analysis showed all rods were orthorhombic in structure with reduction in orthorhombicity upon doping. For all samples, the *I-V* curve showed a relatively constant output current after the appearance of hot-spot. The magnitude of the constant output current was observed to be decreasing with increasing Pr doping which indicates possible reduction in intrinsic hole concentration. In addition, the output current for rods with x = 0.0, 0.05 and 0.10 showed a sudden drop upon the appearance of hot-spot, due to the sudden increase in hot-spot temperature, before becoming slightly constant. However, the sudden drop of output current upon appearance of hot-spot was not observed when Pr was increased to x = 0.15 and 0.20 but instead a stable output current was observed. Interestingly, the output current after appearance of hot-spot for all rods showed strong dependency on ambient oxygen concentration. The sensitivity for

each rod, however, reduces with increasing ambient oxygen concentration. The doping seems to prevent the sensitivity from dropping to almost zero as was previously reported for $Eu(Ba_{1-y}Pr_y)_2Cu_3O_{7-\delta}$ rods due to existence of Cu-O chains in the orthorhombic structure. Pr doping (for x = 0.10) has also resulted in better oxygen absorption response time and better output current stability compared to other rods.





13.3 Group Information and Background of Members

Name of RIG	Ceramic Gas and Magnetic Sensor Materials Research Group (CGMSM)
Leader	Dr Misbah Bin Hassan
Tier	5
RIG Code	CoRe108/T5/2014(33)/FMIA/7
Registration Year (Senate Approval)	1 Julai 2016
UiTM Niche Area	Chemicals and Advanced Materials
RIG Niche Area	Spintronic –based manganites for future magnetic sensor element Novel oxide materials : Ceramic gas sensor element

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14.0

SYNTHESIS AND APPLICATIONS OF CONDUCTING POLYMER RESEARCH

Tan Winie, Chan Chin Han, Famiza Abdul Latif, Oskar Hasdinor Hasan, Tay Chia Chay, Sharil Fadli Mohamad Zamri, Fadiatul Hasinah Muhammad

14.1 Introduction

The synthesis and application of conducting polymers research group (SACPRG) was establish in 2015. This research group focus on the synthesis and application of conducting polymers for electrochemical applications such as in lithium batteries, supercapacitors and solar cells.

Many activities emphasize on the following areas:

1. Synthesis of new polymer
2. Study on homogeneity of polymer blend
3. Fabrication of electrochemical system such as lithium battery, proton battery, supercapacitor and solar cell

Consultations services:

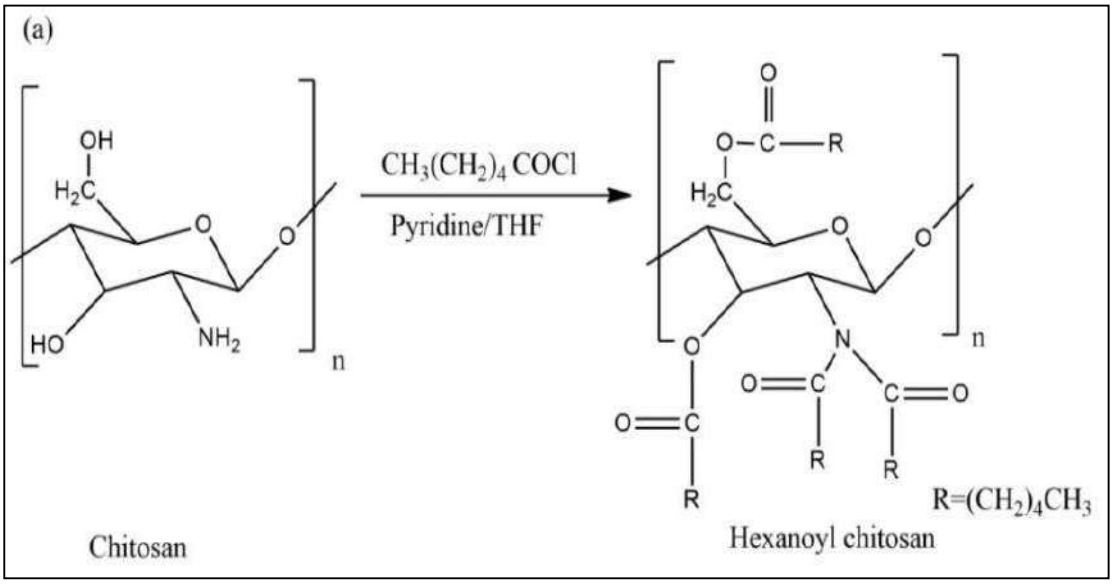
1. Differential Scanning Calorimetry (DSC)
2. Thermogravimetric Analysis (TGA)
3. Electrochemical Impedance Spectroscopy(EIS)
4. Fourier Transformation Infrared (FTIR)
5. Consultation and Industrial Collaboration
6. Instrument short courses and training

14.2 Research Highlights

14.2.1 Synthesis of new polymer

Chitosan, a natural polymer was chosen as a polymer host due to the presence of lone pair electrons at the nitrogen and oxygen atoms which enables coordination with the cation from the salt. Chitosan is attractive polymer host owing to their abundance sources, low cost and non-toxic. However, the insolubility of chitosan in a large number of solvents has limited it to be utilized widely. This is due to the rigid crystalline structure of chitosan caused by the formation of hydrogen bonding between amino and hydroxyl groups. Acyl modification of chitosan was carried out to improve the solubility of chitosan. Hexanoyl chitosan is synthesised by acyl modifying

conventional chitosan. This process involved the substitution of the four hexanoyl ($C=O\ (CH_2)_4CH_3$) groups into C-2, C-3 and C-6 positions in the structure of chitosan after removal of four hydrogen bondings at the hydroxyl and amino groups. The substitution of hexanoyl group has converted the amino group into the imide group. Presence of lone pair electrons in the structure of hexanoyl chitosan allowed complexation with the salt. This makes hexanoyl chitosan a conducting polymer.



14.2.2 Study on polymer blends

Electrolytes of hexanoyl chitosan and salt do not exhibit sufficient conductivity and mechanical stability for application. Hence, polymer blends and composites have been studied. Hexanoyl chitosan has been blended with polystyrene, ENR25 and poly(vinyl chloride) (PVC). TiO_2, SiO_2, Al_2O_3 have been used as the composites. Miscibility behaviour of hexanoyl chitosan and poly(vinyl chloride) (PVC) blends was investigated using dilute solution viscometry (DSV) and FTIR spectroscopy. Both viscometric and FTIR results showed that hexanoyl chitosan and PVC are immiscible for all compositions under investigation.

(Blend 90/10)

(Blend 50/50)

14.2.3 Application in energy devices

Application of various hexanoyl chitosan-based polymer blends and composites were explored. Their performance in lithium batteries, supercapacitors and solar cells were investigated. The highest conducting system was used for the fabrication of dye sensitized solar cell (DSSC) with the efficiency of 2.48% indicating that the blend system has potential to be applied in DSSC.



14.3 Group Information and Background of Members

Name of RIG	Synthesis And Application Of Conducting Polymers
Leader	Assoc. Prof. Dr. Tan Winie
Tier	5
RIG Code	CoRe82/T5/2015(16)/FMIA(12)
Registration Year (Senate Approval)	Julai 2017
UiTM Niche Area	Advanced Materials
RIG Niche Area	Polymer for energy material

Assoc. Prof Dr Tan Winie
Faculty of Applied Sciences
Expertise:
Solid State Ionic

Assoc. Prof DR. Famiza Abdul Latif
Faculty of Applied Sciences
Expertise:
Conducting Polymer

Assoc. Prof Ir Oskar Hasdinor Hassan
Faculty of Art and Design
Expertise:
Electroactive, Material, Polymer Composite

Assoc. Prof. Chan Chin Han
Faculty of Applied Sciences
Expertise:
Polymer

Fadiatul Hasinah Muhammad
Foundation
Expertise:
Solid State Ionic

Dr Tay Chia Chay
Faculty of Applied Sciences
Expertise:
Polymer

Sharil Fadli Mohamad Zamri
Faculty of Applied Sciences
Expertise:
Conducting Polymer

References

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15.0

POLYMER AND MATERIALS PROCESSING ENGINEERING

Rahida Wati Sharudin, Rahmah Mohamed, Ana Najwa Mustapha, Suhaiza Hanim Hanipah, Suffiyana Akbar, Christina Vargis Jones, Arbanah Muhammad, Ahmad Ramli rashidi

15.1 Introduction

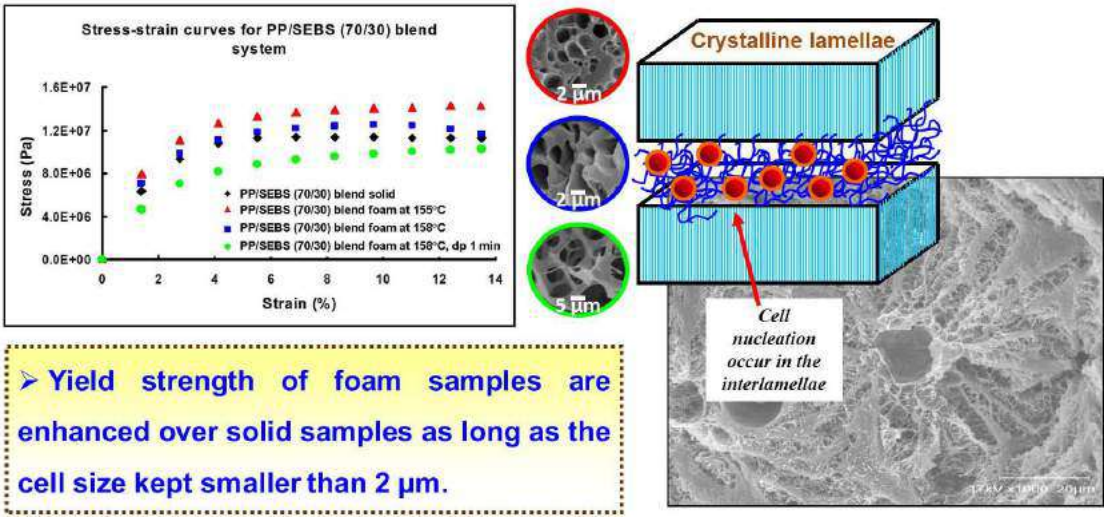
Basically, Polymer and Materials Processing Engineering Research Group activities deals with a wide range of study related to polymer as main material. This group is focusing on 4 areas which polymer blending, polymer foaming, drying by supercritical fluid (scf) and employing modeling and simulation systems to predict the optimum processing conditions. The concern of those 4 areas are coming from the fact that the material functions are strongly related to the material structures in the level from nano, micro to macro-scales. Therefore, the focus will be put at the beginning of the process itself. And now, the research expands to the structure control by integrating with scf technologies; foaming for preparing functional material for lightweight application.

15.2 Research Highlights

15.2.1 Polymer Foam

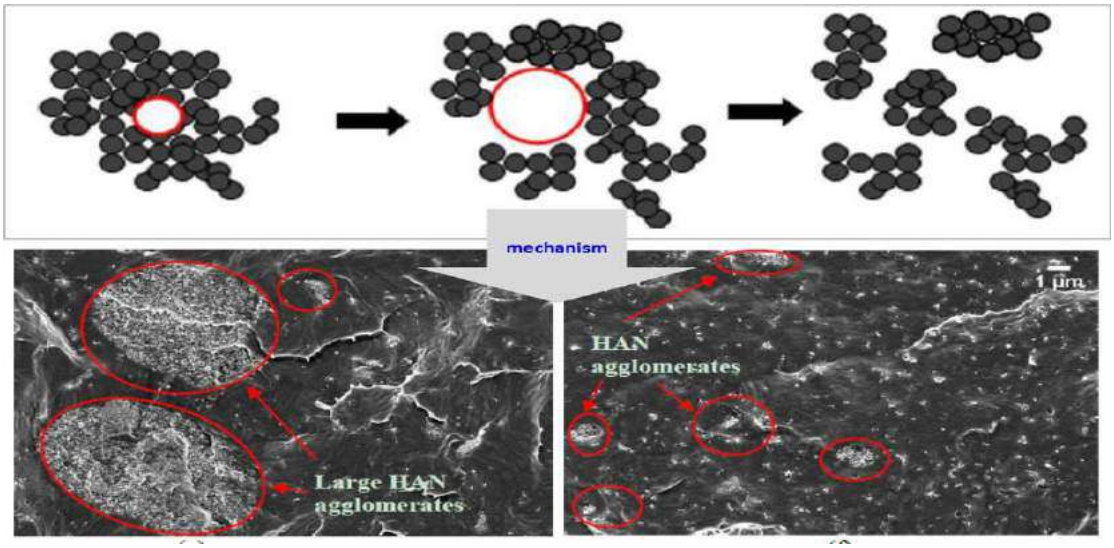
Polymer foams are a class of lightweight material that possesses unique properties and amazing versatility. They are found virtually everywhere either in liquid or solidified form and are widely used for packaging, household, automotive parts, insulation and other applications. Such various applications are due to their porous structure and superior properties of lower density of foams. The advancement of foaming technology is still in progress and the demand on foam products is being widely expanded. The essential concerns of the polymer foams are their final foam structures and cell properties in order to achieve the demanded high functionality-to-weight ratio for any polymer foams. For example, to reduce thermal conductivity or increase heat insulation ability to the level being comparable to that of vacuum insulation materials, the average cell size of foam should be reduced to be smaller than the mean free path of gas molecules of air. The requirements for bio scaffold applications are to be higher porosity, adequate pore size, structural integrity and shape stability to the tissue defect for enabling the tissue regeneration during implantation. As described, the required final cell properties and cellular structure are highly depending on their application. The relationship between cell properties and the overall performance of foam needs to be well understood so as to prepare the optimal foam with respect to the targeted application of the foam. Therefore, it is vital to design the cell property and the structure prior to production of the foam by controlling the cell property and structure by the aid of the following strategies like optimizing the foaming temperature and pressure, utilizing nanofiller or crystal nucleating agents, adapting the polymer rigidity (rheological properties), modifying

the foaming schemes, using different or mixed blowing agents as well as selecting an appropriate pair of polymer for polymer blend foam.



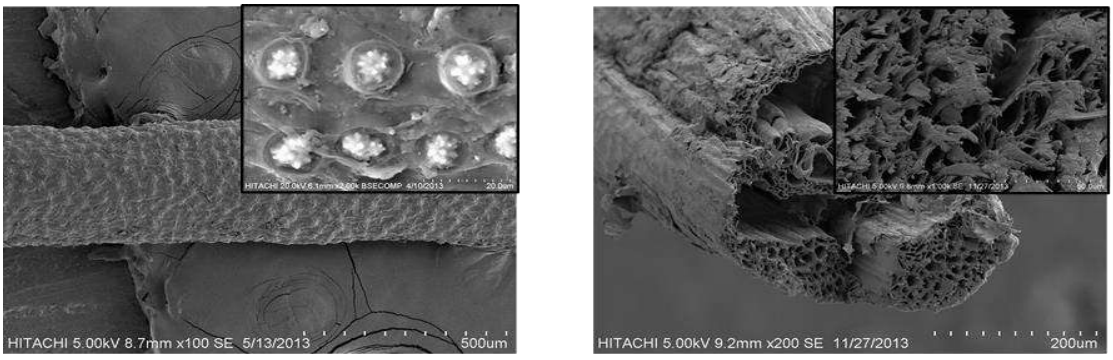
15.2.2 Porous Polycaprolactone/Hydroxyapatite (PCL/HA) Composite by Foaming Process using Supercritical Carbon Dioxide

Bone tissue engineering is a rapidly developing area due to promising a new approach for bone repair. A lot of effort has been placed for designed bone tissue regeneration scaffold. One of essential requirement is mean pore size of scaffold. It plays an important role in the rate and degree of new bone growth. The optimal pore size for bone regenerative is not well defined. From the previous studies with different range of pore size reported, show that, for facilitating osteogenesis (bone tissue formation) the bi modal pores distribution is essential. In this study, bimodal porous PCL/HA composites were fabricated by foaming process using supercritical carbon dioxide ($ScCO_2$) at 10MPa pressure with temperature 40°C for 4hours CO_2 dissolution with rapid depressurization rate. The advantage of this method compared to previous methods is free of organic solvent. Morphology evaluation by FESEM measurement and software Image J found that bi modal pore distribution with 63.52% of porosity was successfully fabricated as high at 40 wt% of HA. As a conclusion, this study found that distribution of HA particles significantly affect the bi modal cellular structure discussed based on heterogeneous nucleation theory.



15.2.3 Micromechanics of Natural Fibre

Micromechanics study of natural fibre were rarely done by Malaysian's researcher. Therefore, this research was taken into account. Prior to micromechanics modelling work of an oil palm fibre which considers silica bodies on the surface and cellular structures within the cross section, an X-ray micro-tomography (µ-CT) analysis on a single fibre and Scanning Electron Microscopy (SEM) can be an exclusive method in morphological study of natural fibre before the inclusion of micro modelling information was then imported into a finite element software, Abaqus. It is quite difficult to see clearly the cellular structure of the fibre, which surface might have changed during handling and cutting of the sample. Therefore, volumetric scanning via µ-CT could help in better understanding of the inner intersection of the natural fibre. Approximately similar images from different slices were obtained, corresponding to different fibre heights (up to ~250 µm), which indicates that the repeated cell walls are arranged in longitudinal direction of the fibre. Ideally, a finite element (FE) model can be generated through reconstruction of µ-CT slices at different height to generate FE meshes. With both methods, the micromechanics study is compliments each other.



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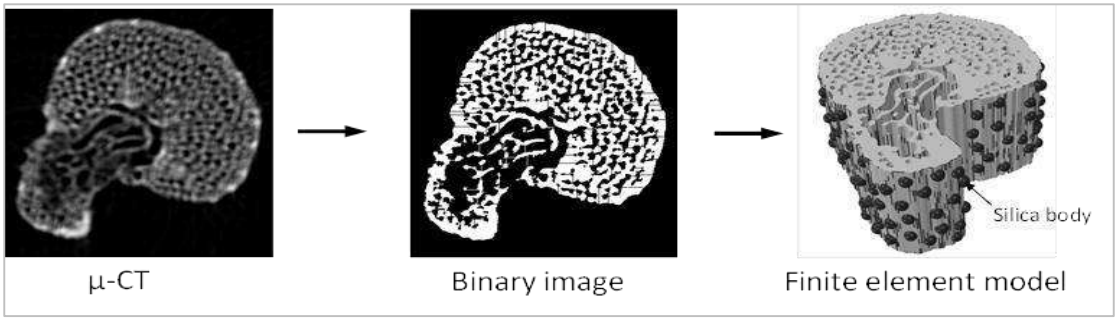
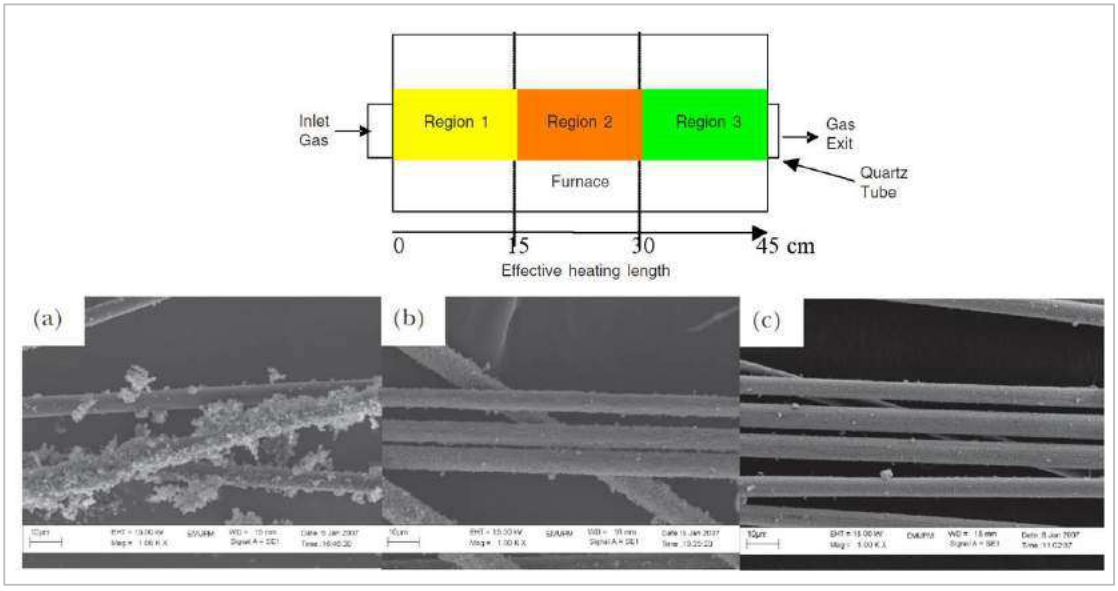


15.2.4 Carbon Vapor Deposition Whiskerization Treatment Process For the Enhancement of Carbon Fiber Composite Flexural Strength

Carbon fiber composite performance can be enhanced by applying an optimum level of fiber surface treatment such as whiskerization. Studies show carbon nanotube (CNT) are able to grow onto the carbon fibres with the highest amount of whiskerization occurring for samples nearest the reactant gas inlet of the carbon vapour deposition (CVD) Rig. The CVD Rig (PI20080489) used in this work generally comprises a precursor handling system, a furnace reactor and a byproduct exhaust system. The precursor handling system mixes and meters hydrogen, benzene and ferrocene. Benzene was used as the carbon source, ferrocene was used as the precursor for iron (Fe) catalysts and hydrogen as the carrier gas. The precursor handling system was connected to a furnace reactor which comprises a quartz tube placed in a horizontal split tube furnace. The quartz tube which holds strands of Polyacrylonitrile (PAN) based carbon fiber is finally connected to the by-product exhaust system which constitutes a simple cyclone separator, condenser, air filter and vacuum pump. This unit treats the effluents in the exit gas before venting it into the fume hood. Various whiskerization behaviours are observed at different reaction temperatures and flow rates. From flexural tests, it was found that whiskerization treatment on carbon fibers increases the flexural strength of its composites between 44-122%



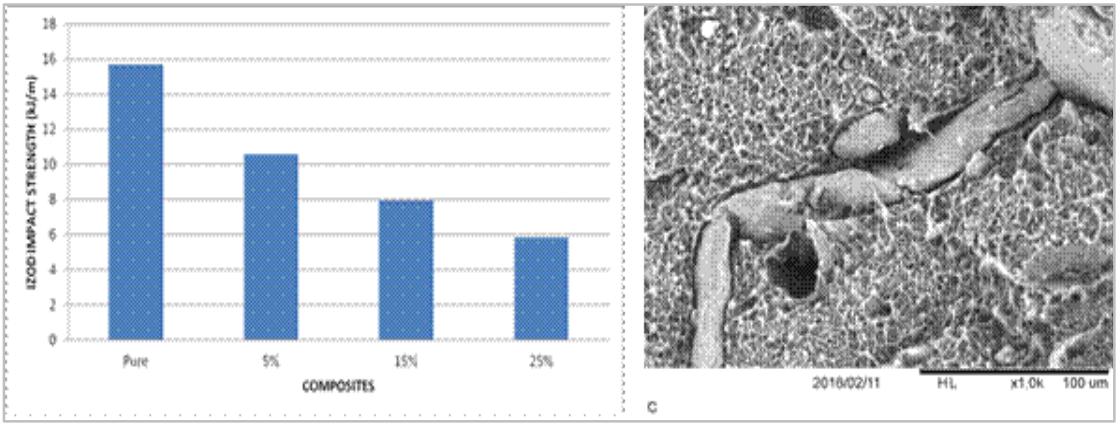
15.2.5 Biocomposite Table from Hybridization of Kenaf and Glass Fibre

Most of the time, furniture such as table was made from wood which are easily broken and easily eaten by termites. This furniture if exposed to wet condition, it can give bad effect towards table. Therefore, the introduction of jute and glass fibre hybrid can solved these problems. Moreover, this table can provide excellent potential in view of their low density, high specific strength and modulus, low extensibility, no health risk, renewability and much lower energy requirement for processing. Furthermore, it is 100% bio-degradable and recyclable and thus, environmentally friendly. The combination of jute and glass fibre blend can reduce the portion of synthetic fiber in the composites. In this case, the glass fiber is still be used because it could be easily be moulded into any shape and has strong mechanical strength to support the jute fiber. To view on its commercialization aspect, the mechanical properties of hybrid table were analysed on their tensile strength and flexural strength. The present project can provide alternative ways on further developing biocomposite material for other application.

15.2.6 Biocomposite from Recycled PET with Hevea Brasiliensis Leaves

The composite materials based on organic filler have received considerable attention from researchers. As a new-generation green composite, natural filler reinforced with

polymer composites has been developed lately due to its ability to enhance the performance characteristics of composites. High Density Polyethylene (HDPE) and recycle Polyethylene Terepthalate (RPET) composite reinforced with Hevea Brasiliensis Leaves (HBL) at various filler contents were prepared by using extrusion and injection molding processes at controlled temperature.



15.3 Group Information and Background of Members

Name of RIG	Polymer and Material Process Engineering
Leader	Dr. Rahida Wati Sharudin
Tier	5
RIG Code	CoRe147/T5/2017 (7)/FMIA(24
Registration Year (Senate Approval)	26 October 2017
UiTM Niche Area	Chemical & Advanced Materials (W)
RIG Niche Area	Research on preparing functional materials with improved properties by controlling various processing conditions and the materials' properties

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16.0

PHOTONICS AND MATERIALS RESEARCH

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16.1 Introduction

The Photonics and Material research interest group (RIG) was established in 2014 under the Faculty of Applied Sciences and is registered with the Research and Management Institute (RMI). The group comprises of members from various UiTM campuses such as UiTM Shah Alam, Dengkil, Negeri Sembilan and Pasir Gudang, and the group comprises of members, associated members and honorary member. Research work are conducted in the university and in collaboration with other local and overseas groups and laboratories.

Website: https://photonic.uitm.edu.my/

16.2 Research Highlight

16.2.1 Experimental investigation of Optical Materials

Investigation of rare-earth element's ability to absorb and emit light at different wavelength. The presence of both nanofiber and thin film layers of rare-earth (RE) doped silicate within a single structure exhibited a broader spectral width due to simultaneous luminescence emissions from both layers. Broad bandwidth is significant because it enables the design of tunable lasers and meets the demands for faster internet and computer powers. The Photonics and Material group investigate the effect of nanofiber/thin film multilayers on the properties of Tm3+/Yb3+ co-doped SiO2-HfO2. This multilayer structure comprises of thin film and nanofiber is prepared via sol-gel dip-coating and electrospinning techniques, respectively. We expect an enhanced effect of nanofiber/thin film multilayer on the structural and optical properties of Tm3+/Yb3+ co-doped SiO2-HfO2 with new nano-structural approach and material combination for broader bandwidth and higher luminescence intensities.

16.2.2 Optical Sensors

Work on all optical sensor includes "Health Monitoring in Honeycomb Sandwich Composite for Aircraft Structure using Fiber Bragg Gratings", "All Fiber Distributed Displacement Sensor", and "Long Period Fibre Grating (LPFG) Ethanol Sensor Based on Surface Plasmon Resonance"

16.2.3 Nonlinear Optical Materials

Theoretical investigation of optical switch in optical computing and the future all-optical devices. Materials exhibiting optical bistability (OB) are the best candidates for making optical switches, logic gates, and memory elements. Two-beam Kretschmann-Raether configurations is investigated to generate SPP waves at the (i) metal-ferroelectric, and (ii) graphene-ferroelectric layer interfaces. The usage of graphene film, instead of the metallic layer is expected to significantly improve the efficiency of the device due to the outstanding electrical characteristics of graphene and its ability to support the p-polarized SPP wave.

16.2.4 Design and Optimisation of Photonic Devices and Sensors

Design work are mainly conducted using commercially available software such as FIMMWAVE, RSoft Beamprop, Optiwave FDTD, COMSOL and ZEMAX. Among recent projects completed are fabrication of Tunable Highly Multimode Optical Fibre Power Splitter, Simulation of Transverse Optical Scattering of Protein Infiltrated Photonic Crystal Fibre, Nano slot waveguide sensor and Mode Dispersion Analysis of Tapered Fibre Protein Sensor.

16.3 Group Information and Background of Members

Name of RIG	Photonics And Materials Research
Leader	Associate Professor. Dr. Mohd Hanapiah Bin Mohd Yusoff
Tier	5
RIG Code	CoRe147/T5/2017 (7)/FMIA(24
Registration Year (Senate Approval)	2014
UiTM Niche Area	Photonics
RIG Niche Area	Research on optical materials, optical fiber sensors, non linear optics, design and simulations of photonics sensors and devices

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12. Prof. Dr. Mohd Kamil Abd Rahman, email: drkamil@uitm.edu.my

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17.0

ORCHESTRATED POLYMER RESEARCH GROUP (OPoR)

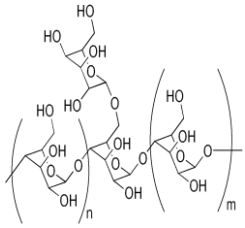
Dzaraini Kamarun, Rozana Mohd Dahan,Ramlah Mohd Tajuddin, Engku Zaharah Engku Zawawi, Hamizah Mohd Zaki and Norazura Ibrahim

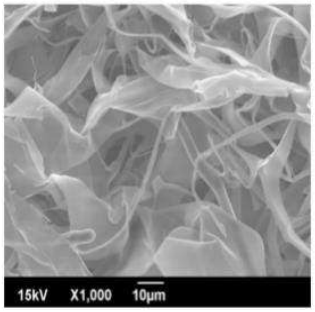
17.1 Introduction

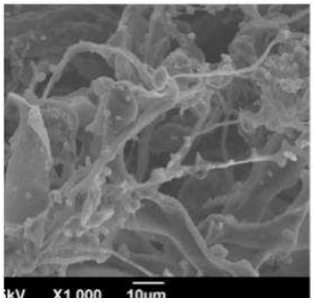
17.2 Research Highlight

17.2.1 Galactomannan nanoparticles for drug delivery

Galactomannan extracted and purified from the plant Leucaena leucocephala (petai belalang) are modified and cross-linked to produce galactomannan nanoparticles. A peptide cross linker molecule, labile to the enzyme Human Neutrophil Elastase (HNE) are incorporated into the galactomannan nanoparticles to render it biodegradable under the action of the enzyme. HNE is often implicated in diseases related to respiratory disorder such as chronic obstructive pulmonary disease (COPD) and adult respiratory distress syndrome (ARDS) in humans. It is produced in excess during inflammation and infection of the diseases. Interactions of HNE with the peptide cross links in the galactomannan nanoparticles caused disintegration of the galactomannan nanoparticles causing the drug to be released. This mode of drug delivery is expected to solve drug loading problems and controlled release of drugs faced by current drug delivery system.







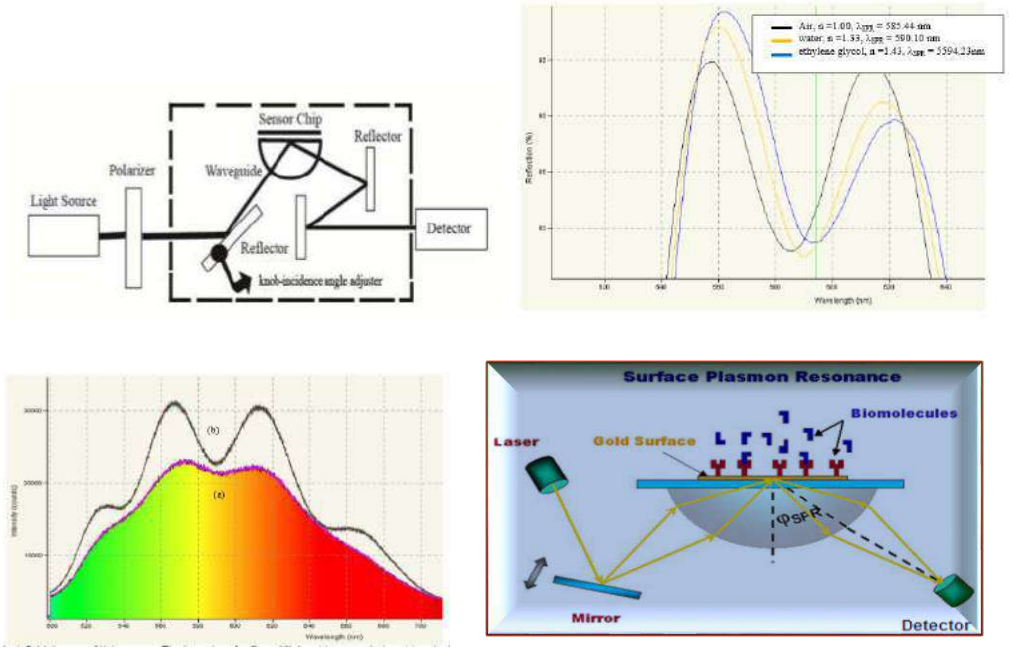
17.2.2 High fiber loading Luffa/PP composites panels

Industrial application of biocomposite materials based on natural fibers contribute significantly to the development of ecofriendly products. Natural fibers such as hemp, jute, kenaf, sisal, and bamboo had long been used for such purpose and related researches are widely documented. Luffa is another natural fiber reported by several researches. It is harvested within 3 months as compared to other fibers such as kenaf which is 5 months; thereby making it an economical alternative. Conventionally, natural fibers incorporated in polymer composites constitute 50% of the overall composition. Increasing the fiber loading to as high as 60% reduce the tendency of the composite to undergo chemical and mechanical deformation such as shrinkage and warping besides being more ecofriendly. However, higher percentages of fiber loading create problems such poor mixing and components inhomogenity. Therefore a method to improve the mixing of the ingredients need to be developed.

17.2.3 Development of SPR/LSPR device

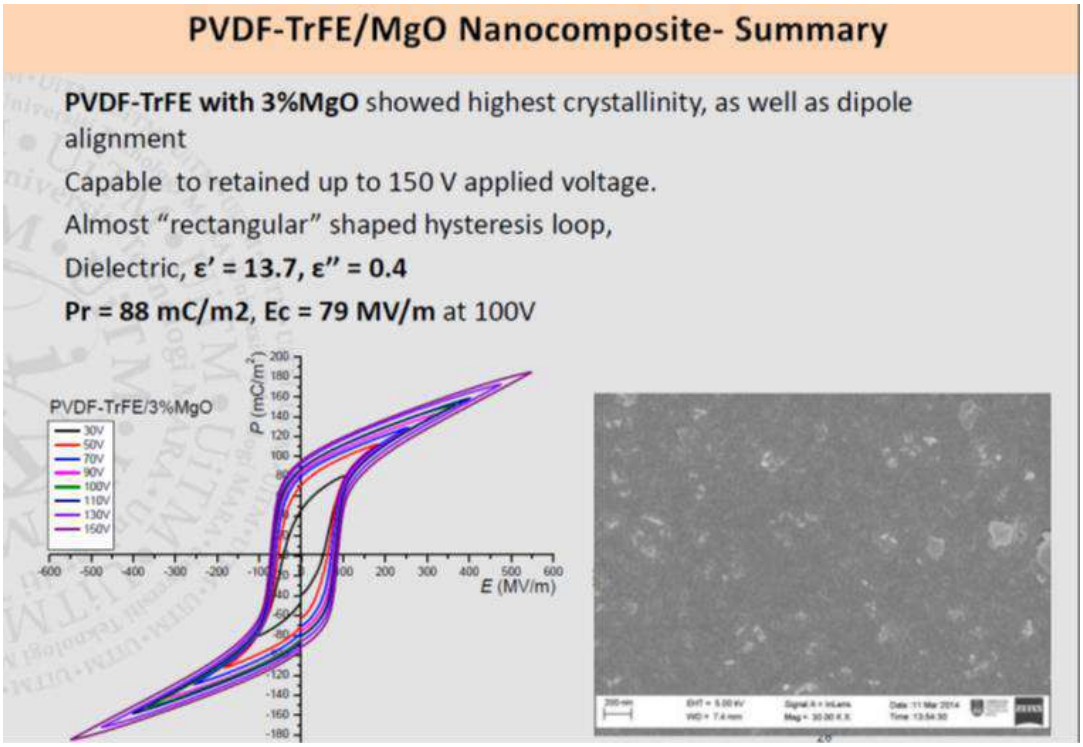
Modular surface plasmon resonance (SPR)/LSPR biosensor device based on wavelength modulation wherein the angle of incidence of the light source is fixed and the shift in wavelength at resonance is monitored is developed. This device is capable of detecting biomolecular binding interactions of different species such as proteins, oligonucleotides and viruses. White light source mounted with a polarizer is used to excite plasmons on the sensor surface which is a thin gold film of ~ 21 µm thickness coated on a glass disk in SPR and gold nanoparticles in LSPR. A variable-angle reflection sampling system (VARSS) device from Ocean Optics was modified

to incorporate the transducer components and sampling accessories. SPR was observed at the angle of incidence of the light fixed at 29°. At this point, Plasmon-evanescent wave coupling occurred with highest loss of light intensity. HR4000-UV-NIR photodetector is used to observe the change in resonance wavelength when the dielectric environment around the surface of the transducer was changed.



17.2.4 Fluropolymer Nanocomposite Films for Ferroelectric Application

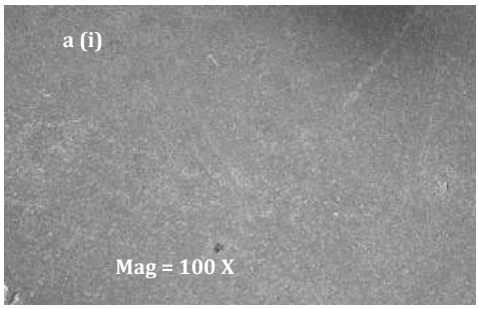
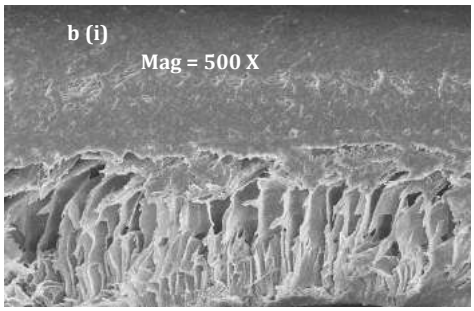
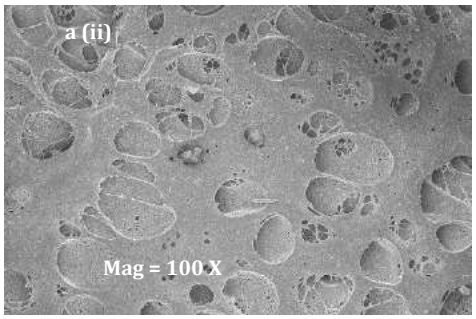
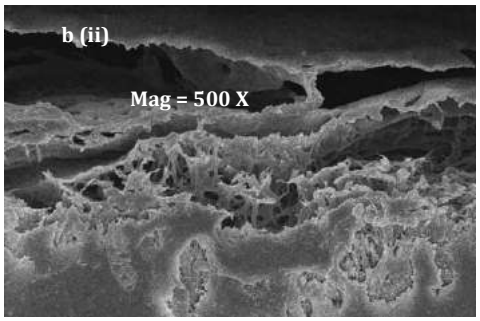
The dielectric and ferroelectric properties of flouropolymer films as active film layer for electrical application have generated great interest due to the ease of processing and the possible utilization of these fluorpolymer thin film at low application voltage. To date, nano composite films, comprising of PVDF homopolymers or PVDF-TrFE copolymer incorporated with oxides as nano fillers are widely investigated for their electrical and resistivity properties. This paved way for novel method of producing these films. Studies have suggested that increment of nano fillers percentage, would typically resulted in an increment of the dielectric and ferroelectric properties of the nano composite films. However, the optimize percentage of the nano fillers incorporated is imperative for favourable filler dispersion and consistency of electrical measurements. In this study, different preparation techniques were utilized to enhance the electrical properties of the nano composite films. In the first instance, different nano fillers types were incorporated in the polymer matrix to produce a single nano composite film. Then, multilayer nanocomposite films were produced, which consists of nano filler film with varying types of nano fillers and a floropolymer film layer. These single layer and multi-layer nano composite films were then analysed and measured for their electrical.



17.2.5 Membrane for Nutrients Reclamation from Kenaf Retted Wastewater

Water retting is the main challenge faced during the processing of bast kenaf plants. This conventional method has been reported to generate much water pollution. Polysulfone membranes were fabricated with and without additives to study the performance in nutrients reclamation for kenaf retted wastewater. The effects of additives on the membrane morphology and membrane permeability were also investigated. The addition of the additives into the dope solution altered the morphology and the structure of the resultant membrane. It was observed that the additives significantly increase membrane permeability and improve reclamation of nutrients. The membrane cross-sections were monitored by using the scanning electron microscopy (SEM). The results indicated that by increasing the concentration of additives, the morphologies changed from finger-like to sponge-like structure. It should be noted that membrane fabricated with additives (P10) of shows better performance by reclaiming more than 85% of nutrients from kenaf retted wastewater. It should be noted that membrane P10 was able to reclaimed total nitrogen, total phosphorus, and potassium by 95.6%, 92.1% and 88.2%, respectively. This proved that, additional of additive in membrane dope composition improved the membrane performance effectively.

SEM image of the (i) surface layer and (ii) cross section for fabricated PSF membranes

Membrane	Morphology	
	Surface Layer	Cross Section
P0		
P10		

17.2.6 Properties of Linear Low Density Polyethylene/Poly (Lactic Acid) Blends

This study blending of LLDPE and biodegradable polymers, PLA are significant effort to reduce the volume of waste in packaging materials derived from petrochemicals. PLA (Polylactic acid) is typical biodegradable polyester obtained by the synthesis of lactic acid, which can be produced from renewable resources like corn or sugarcane. In general, PLA is the most promising plastic as its tensile strength and stiffness are similar to polyethylene terephthalate. However, PLA is too brittle to be used in commercial applications and toughening is generally required. Besides that, cost of PLA is quite high; therefore it is not economically feasible to use it alone for day to day use as a packaging material without blending. Blending PLA with polyolefin, such as polyethylene (PE) and polypropylene (PP) will be beneficial as polyolefin find extensive use in plastic packaging. In this research linear low density polyethylene (LLDPE) was chosen to be blend with PLA because of ease of processing, low cost and it properties such as more flexible and better clarity as compare to others polyolefin materials.

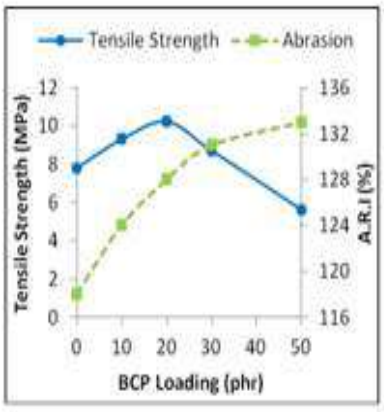
17.2.7 The effect of chemical treatment on rice husk ash filled natural rubber composites

Rice husk ash (RHA), a waste product of the rice industry is rich in silica. A chemical treatment on RHA by a simple method based on alkaline extraction followed by acid precipitation was developed to produce silica from RHA. The effect of chemical

treatment on particle size and surface area was measured. Precipitated RHA was then incorporated into natural rubber (NR) using a laboratory size two-roll mill. The cure characteristic and mechanical properties of the two compounds were evaluated. For comparison purposes, commercial precipitated silica was also used. It was found that treating RHA with chemical treatment (digestion and precipitation) significantly decrease particle size of RHA and increases the RHA specific surface area. As for precipitated RHA, inspite of parameters such as surface area and particle size, the vulcanizate with 20 phr of this filler, showed physical properties not much inferior to commercial silica filled vulcanizates. Silica obtained under these conditions has potential application as filler in plastics and rubber compounding because of its extremely low cost as a by-product of the rice industry. There is also the possibility of having it behave as reinforcing filler if filler–polymer interaction could be improved.

17.2.8 The potential of bamboo charcoal powder as reinforcing for rubber composites

Bamboo is an abundant and inexpensive natural resource. It can be carbonized in a furnace at high temperature in the absence of oxygen to produce bamboo charcoal (BC). BC is plentiful, relatively cheap, renewable, relatively non-toxic and sustainable. Compounds of natural rubber filled with bamboo charcoal powders were prepared with a laboratory-sized two-roll mill. The effects of the bamboo charcoal powders loading on the curing characteristics and mechanical properties were investigated. The results indicate that the addition of bamboo charcoal powders resulted in a longer scorch time and a higher Mooney viscosity in the natural rubber. The incorporation of bamboo charcoal powders into natural rubber improved some of the mechanical properties. Furthermore, the abrasion resistance of the vulcanisates shows great improvement along with the increase of bamboo charcoal powders loading. The overall results indicate that bamboo charcoal powders could be used as filler for natural rubber for economic and ecological reasons.



17.3 Group Information and Background of Members

Name of RIG	Orchestrated Polymer Research Group (OPoR)
Leader	Assoc. Prof. Dr. Dzaraini Kamarun
Tier	5
RIG Code	CoRe58/T5/2014/58/FMIA/9
Registration Year (Senate Approval)	1 Oktober 2016
UiTM Niche Area	Chemical & Advanced Material
RIG Niche Area	**Synthesis, modification and fabrication of polymer and**

	rubber materials for applications in industries and biomedical field
	Polymer Synthesis and characterization, Polymer based biosensor
	Polymer Physics & Composites
	Rubber Technology, Polymer Processing
	Polymer Blends/Polymer Composites

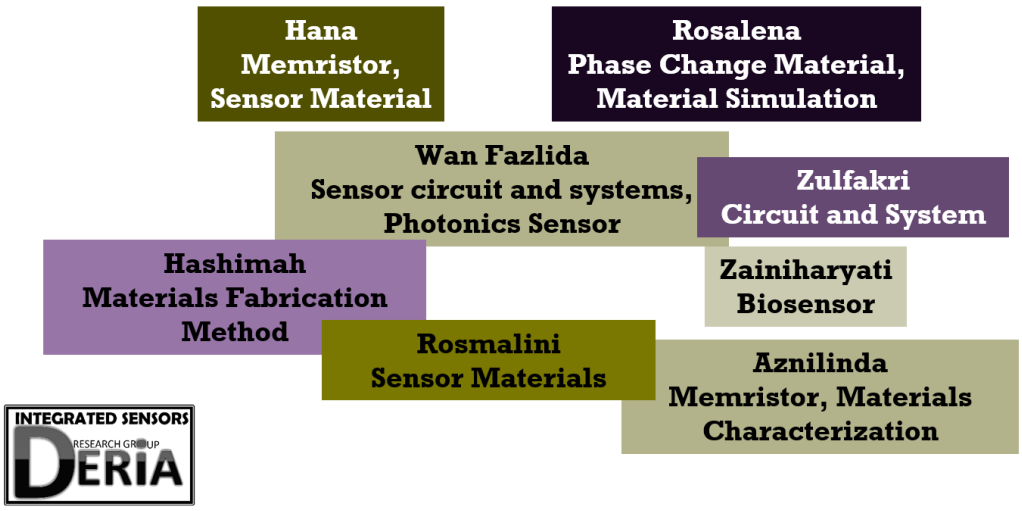
18.0

INTEGRATED SENSORS RESEARCH

Sukreen Hana Herman, Wan Fazlida Hanim Abdullah, Hashimah Hashim, Rosmalini Ab Kadir, Zulfakri Mohamad, Rosmalina Irma Alip and Aznilinda Zainuddin

18.1 Introduction

Integrated Sensors Research Group (DERIA) is formed to enhance multidisciplinary researches while focusing in one niche area; sensor and sensing system. It is unique in a way that each of the member has their own niche fundamental research which when combined forms a complete applied system.



The research activities emphasize on the following areas:

1. Development and characterizations of sensing materials using various fabrication methods
2. Study of materials for other advanced applications such as memristors and new materials such as phase change materials for other advanced possible applications
3. Development of circuits and systems for sensors and sensor systems.
4. Development of working prototypes of sensor system from the developed materials and circuits.

18.2 Research Highlight

18.2.1 Development of Sensing Materials

Sensing materials can be fabricated using various materials, our group is focusing on the metal oxides due to their chemical stability and ease of fabrication methods. Choice of the materials depend on the sensing applications, at present we are focusing on pH sensing. While pH sensor technology is matured, the applications are

endless with new needs keep arising. Our group have been studying various materials for pH application, varying the fabrication methods and choice of materials. We aim to propose the most ideal material and fabrication recipe to produce a sensor with high sensitivity, linearity, and highly reliable. The materials that have been studied for pHare:

- Titanium dioxide (TiO_2) thin films
- Tantalum pentoxide (Ta_2O_5) thin films
- Zinc Oxide (ZnO) nanostructure
- TiO_2 / ZnO bilayer composite

We have reported successful fabrication of several nanostructures by various methods as shown in the figures below. ZnO nanotetrapods, nanoflowers and nanorods were achieved by low-temperature chemical bath deposition (CBD) process.

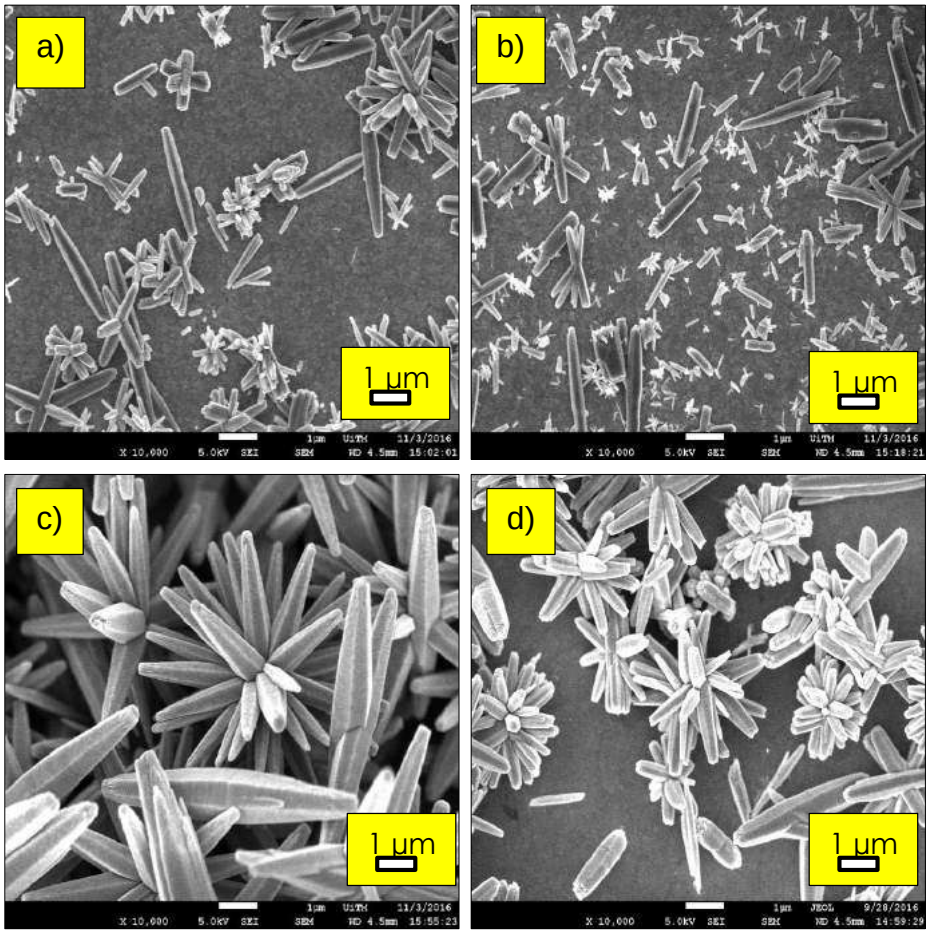
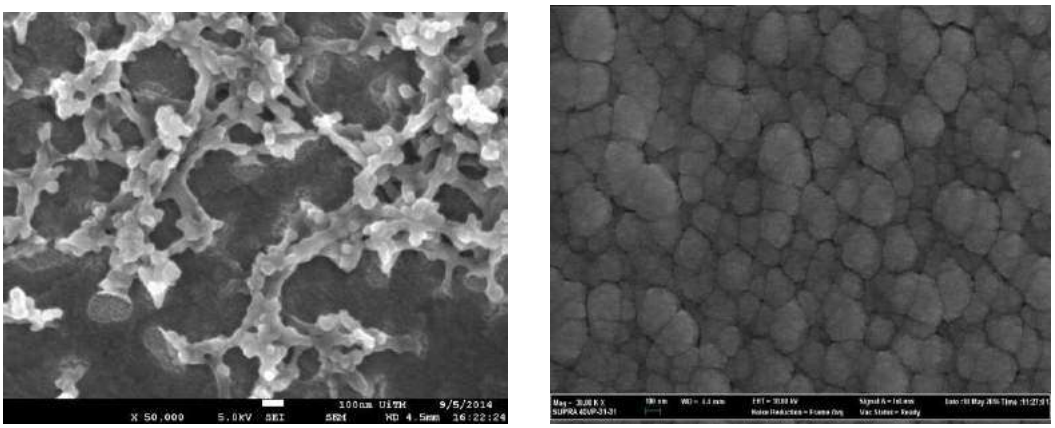


Figure 1. ZnO nanostructures deposited by CBD method for a) 1, b) 2, c) 3 and d) 4 hours deposition.

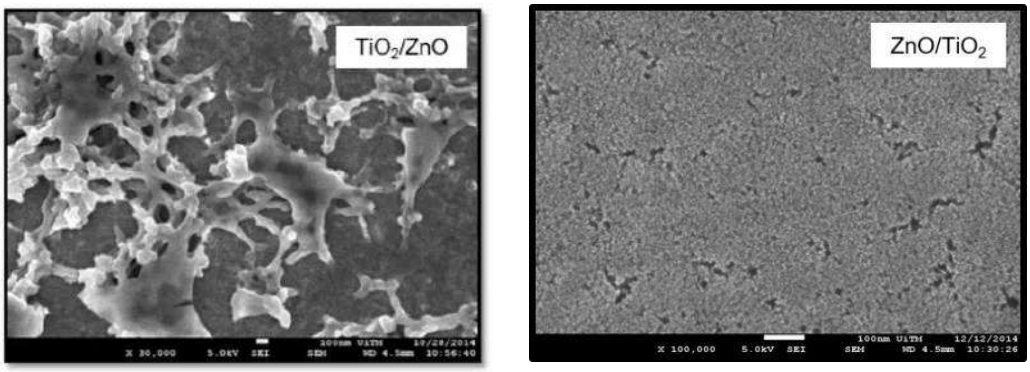
TiO_2 and Ta_2O_5 thin films were successfully deposited by spin coating and sputtering,



respectively. The thin films morphologies are shown in the figure below.

Figure 2. Surface morphologies of spin coated TiO_2 (left) and sputtered Ta_2O_5 (right)

We have also reported on using two types of materials for the sensing layer, namely TiO2 and ZnO bilayer composite, shown in the figure below. The distinct features of



the surface morphologies can be seen clearly.

Figure 3. Surface morphologies of spin coated TiO_2 on ZnO (left) and ZnO on TiO_2 (right)

All of these materials were applied as the sensing layer of an extended-gate field effect transistor (EGFET) pH sensor. The highest sensitivity and linearity of each material are tabulated in Table 1. All of them are approaching the theoretical Nernst value of 59.16 mV/pH with a good molarity approaching to 1.

Table 1: EGFET sensor pH sensing performance of each sensing material in our work

Material	Sensitivity (mV/pH)	Linearity
TiO_2	53.0	0.99

Ta_2O_5	58.7	0.99
ZnO	53.8	0.98
TiO_2/ZnO	57.1	0.99
ZnO/TiO_2	54.4	0.96

18.2.2 Development of Readout Interfacing Circuits (ROIC)

In developing a sensor system, a circuit is needed to convert the electronic signal induced by the chemical reaction to a readable electronic signal that can be transmitted to the system for an output. One of the read-out interfacing circuit (ROIC) being studied and developed in our work is for an extended-gate field effect transistor (EGFET) application. We have reported an ROIC with improved accuracy and solving the body effect and temperature issue usually found in EGFET sensor system. We have designed the ROIC using Silterra 130-nm CMOS technology with the size of 1.2 x 1.1 mm2 having 22 I/O pads. The circuit, having a constant biasing and common reference electrode for this architecture allows parallel measurements resulting in simultaneous measurement with various sensing materials attached. The ROIC was sent for taped out at Silterra.

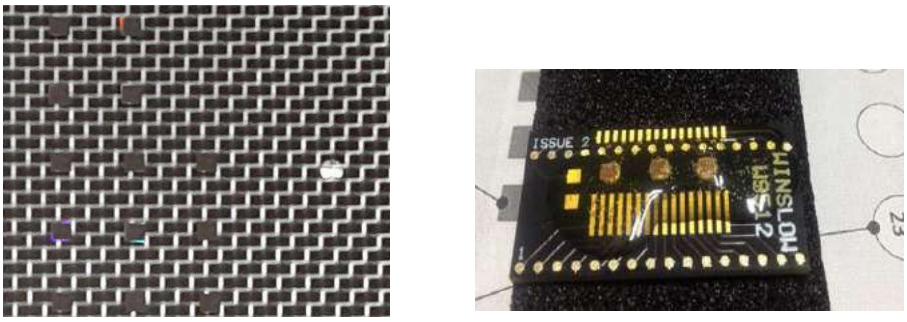


Figure 4. The taped out IC chip for EGFET sensor, before (left) and after (right) packaging

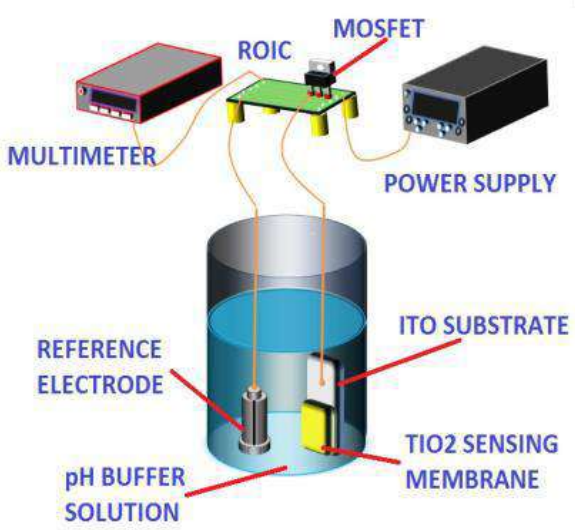
Besides the ROIC for EGFET sensor, our group is also working on the ROIC for amperometric 3-electrode cells for DNA detection.

18.2.3 Extended-Gate Field Effect Transistor (EGFET) pH Sensor

Focusing on developing the pH sensor, we chose the extended-gate field effect transistor (EGFET) sensor as the type of sensor to be developed. While pH sensor technology is a matured technology with commercialized sensors, most of the sensors are not applicable for electronic system connectivity. The on-shelf sensors are independent sensors which cannot be easily connected to an electronic system, for example, to be used in a smart agriculture monitoring system. Thus, we focus in developing a sensor system that can be applied to another electronic system, which can be realized using the transistor based sensor.

Ion sensitive field effect transistor (ISFET) pH sensor was first proposed by Bergveld in 1970, and quickly gained interest by scientists worldwide due to the ability of the sensor to be integrated with many sensing materials such as metal oxides and polymers, with an added advantage of the ability to be manufactured in miniature size. The main problem that arose from ISFET structure was the inability of the device to accurately measure hydrogen ion concentrations when thermal factor was involved. Since the sensing area was directly fabricated on the gate of the FET, temperature variation of the measured solution would influence the transistor characteristics thus altering the results.

The EGFET was proposed to overcome this problem. This structure still applies the same basic principle like ISFET for detecting hydrogen ions in a solution but the obvious difference is that the sensing membrane is detached from the transistor and the sensor system components. Besides solving the thermal issue, this extended gate structure gives several other advantages. It allows limitless modification to be done on the sensing membrane used. This modification may include varying the type



of sensing material used to allow wider choice of measurand and enhance selectivity. It also grants the possibility of altering dimensions of the sensing membrane such as changing the size, shape, and thickness. The EGFET sensor system measurement is shown in the figure below.

Figure 5. Extended-gate field effect transistor (EGFET) pH sensor measurement setup

18.2.4 Phase-Change Materials

Phase change material (PCM) is a material that can be used to store energy or to control the temperature changes within a specific range. When the temperature rises, PCM absorb heat in an endothermic process and changes phase from solid to liquid. As the temperature drops, PCM release heat in an exothermic process, and return to its solid phase. According to their chemical composition, PCM can be categorized as organic compounds, inorganic compounds and eutectic mixtures. Each group has its typical range of melting temperature and its range of melting enthalpy. The paraffin

waxes, salt hydrates, fatty acids and eutectic organic/non-organic com-pounds are the most used since last 30 years. PCM owned special characteristics, which are considered very important in many applications; for instance, in building envelopes (i.e. PCM incorporated into finish materials, thermal insulation or structural components).

In our work, we focus on applying PCM in a solar cell to decrease the operating temperature, as well as enhancing the efficiency of the solar cell. With the addition of PCM and carbon-based material in the solar cell structure, the efficiency of the solar cell could be increased, since the issue of the high operating temperature will be overcame using PCM. PCM has the ability to absorb the excess heat by latent heat absorption mechanism and regulate the solar cell temperature when the operating temperature increase. Due to the low conductivity of PCM, carbon-based material chosen will enhance its performance, and a good solar cell with high efficiency can be achieved. Figure below shows the comparison of surface morphologies of ZnO and ZnO incorporated with polyethylene glycol (PEG) as the PCM.

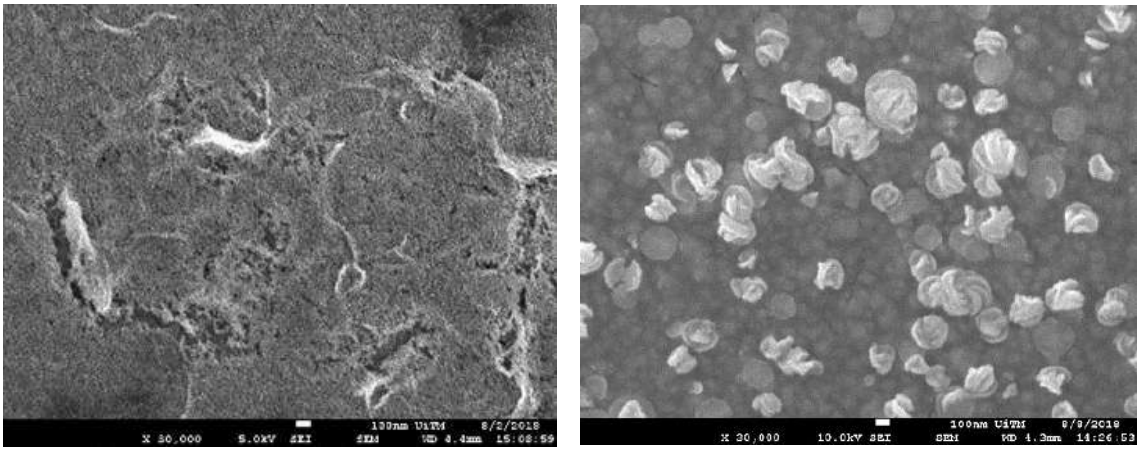
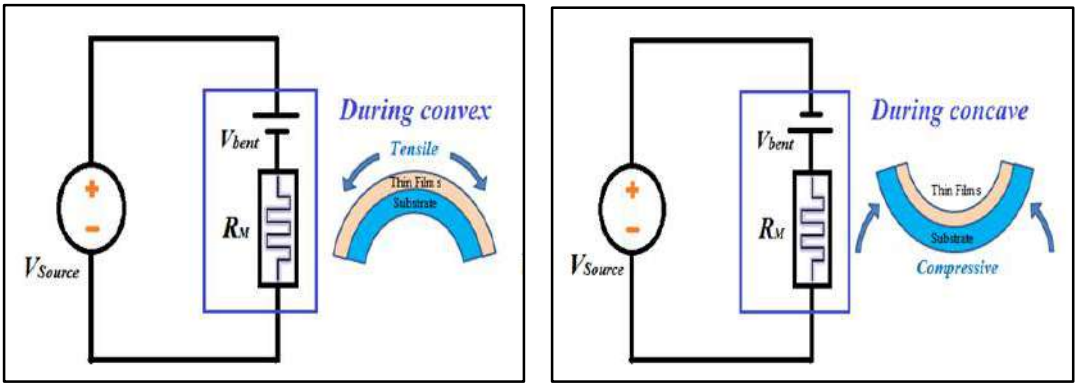


Figure 6. FESEM images of ZnO (left) and ZnO with PEG (right)

18.2.5 Memristor and Memristive Devices

A memristor is a hypothetical non-linear passive two-terminal electrical component that relates electric charge and magnetic flux. It is a component that can limit and regulate the current flow, thus it is said to be able to replace transistors. Theoretically proven by a mathematician, Prof. Leon Chua in 1970, the memristor was not physically fabricated due to needed extremely thin active layer to allow the ionic movement and thus ionic conduction to turn ON and OFF the device. By virtue of the nanotechnology advancement, the first memristor device was physically fabricated in 2008 by HP Labs. Our group has successfully fabricated memristive devices using TiO_2 with Pt electrodes. Although the memristor is generally known to be applied in memory devices due to their non-volatile memory characteristics, the memristors for memory devices need to be fabricated with an extremely thin active layer – which

can be possible using the atomic layer deposition (ALD). In our work, our memristive devices were fabricated using simple spin coating or sputtering method. Although the devices may not be applicable for memory application, we proposed a different application – using the memristive device as a tactile sensor. By fabricating the TiO_2 thin film on flexible PET substrates, we have reported that the memristive behavior



showed distinct variation according to the substrates bending angle, suggesting that it can be applicable as a tactile sensor, provided a suitable ROIC is developed.

Figure 7. Simple circuit diagram to illustrate sample configuration during I-V measurement for tactile sensing testing of memristive device.

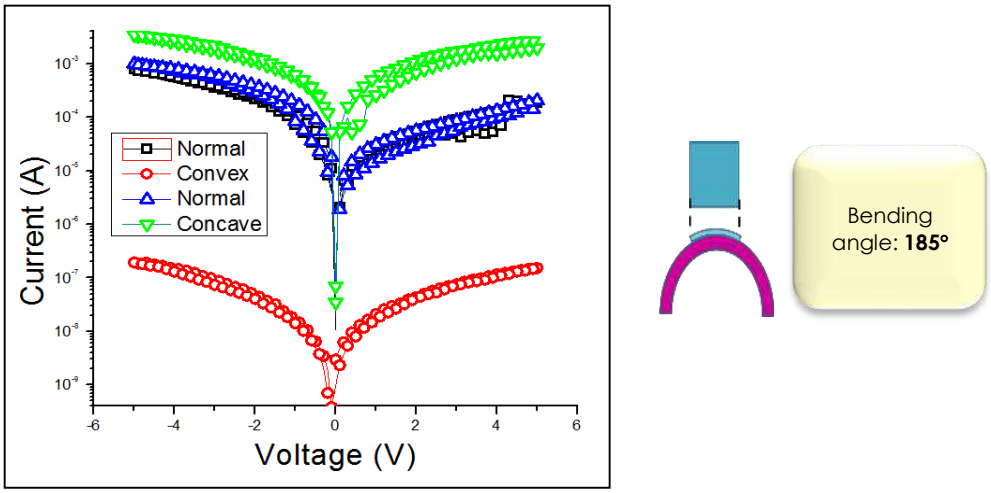
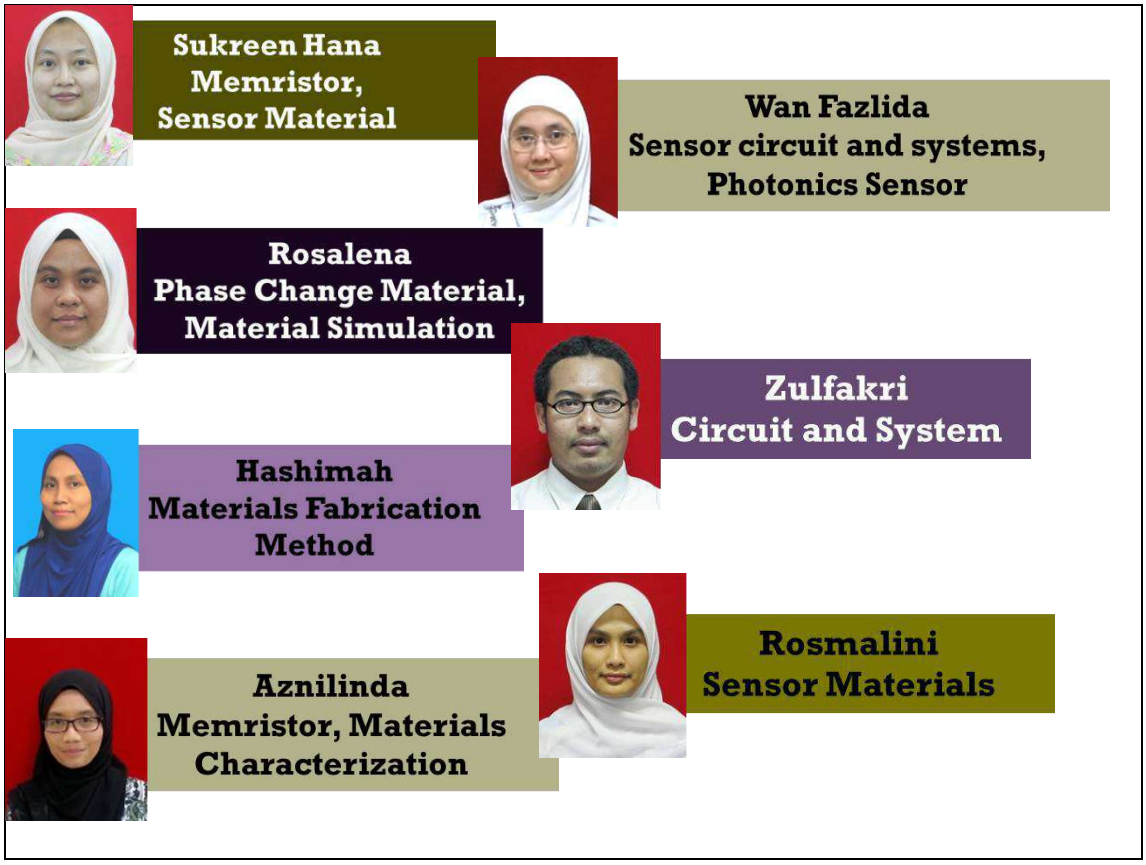
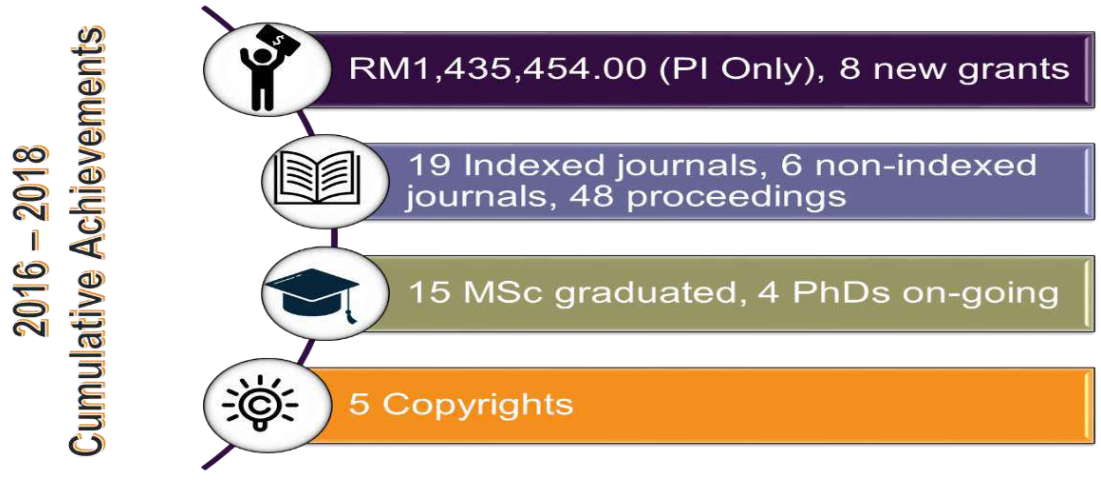


Figure 8. Example of I-V characteristics of memristive device during bending. The difference of the characteristics can be seen.

18.3 Group Information and Background of Members

Name of RIG	Integrated Sensors Research
Leader	Dr. Sukreen Hana Herman
Tier	5
RIG Code	CoRe98/T5/2016 (3)/FMIA(16)
Registration Year (Senate Approval)	14 Januari 2016
UiTM Niche Area	Industry 4.0
RIG Niche Area	Sensor Materials and Sensor System Development





19.0

ELECTROCHEMICAL MATERIALS AND SENSORS (EMaS) RESEARCH GROUP

Lim Ying Chin, Yusairie Mohd, Zainiharyati Mohd Zain, Low Kim Fatt, Mohammad Noor Jalil, Irni Hamiza Hamzah, Wan Fazlida Hanim Abdullah

19.1 Introduction

The nature of our research is highly interdisciplinary, emerging technologies from the fields of electrochemical sensors, microelectrode fabrication, electroanalytical chemistry, surface modification/coatings, electrocatalysis and material science (esp. nanoparticles characterization). Our research group leverage broad expertise in material synthesis.

Ultimately, we plan to design, develop and manufacture novel devices for applications in a number fields in

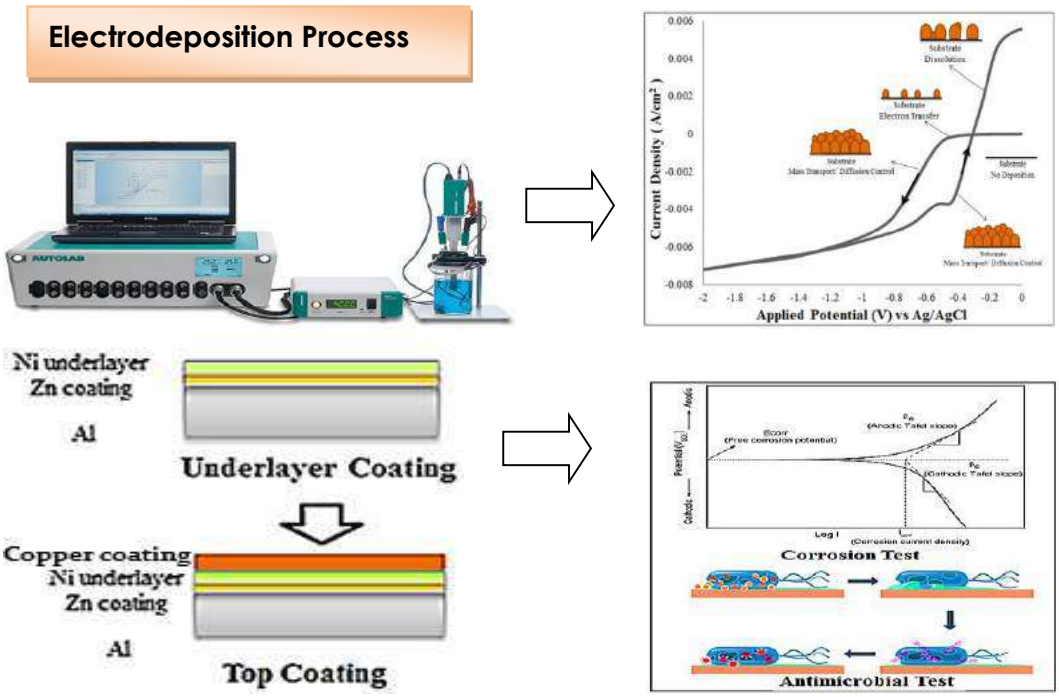
cluding: biochemical sensing analysis, antimicrobial coatings, fuel cell and photovoltaic device development.

19.2 Research Highlight

19.2.1 Surface Modification Via Electrodeposition

Electrodeposition is a fascinating process in which non-functional substrate materials cab be modified to functional materials using electrodeposition methods (eg: Cyclic Voltammetry, Chronoamperometry or Chronopotentiometry) for a broad range of applications; batteries, fuel cells, antimicrobial coatings/particles, sensors and corrosion protection. Electrodeposition has numerous advantages; versatility to

fabricate various functional materials, ease of control (deposition growth and conditions) and low cost technique.



19.2.2 Electrochemical Biosensor in Bioanalysis

Biosensor is an analytical device that consists of three main parts; (i) the biomarker (target molecule), ,(ii) a bioreceptor (recognition element) and (iii) a compatible transducer that is able to capture and produce a readable output . Biosensor has been widely used in bioanalysis because of its simplicity and offers faster analysis time. Electroanalytical techniques are widely coupled with biosensors due to low level of detection and inexpensive laboratory equipment. Moreover, an analyst can quantify the target molecule *in situ.* The used of nanomaterials in signal enhancement such as Glucose oxidase immobilization on the Zinc Oxide (ZnO) – Silicon substrate, prostate specific antigens on Au nanogold and DNA aptamers on ZnO nanowires on Au electrode are discussed. Their limits of detections are at micro level. Novel biocompatible material with acceptable electrical conductivity is also needed to hold the biorecognition element on electrode surface in order to enhance the shelf-life of the biosensor Amperometry technique is used for a time dependent observation of bioelectrochemical reactions of neurotransmitters like D-serine and glutamate oxidase in rat brain (Figure 1). These brain implantable electrodes have to undergo surface modifications with polyphenylenediamine for specificity detection of the neurotransmitters. Differential pulse voltammetry and anodic square wave voltammetry are suitable for potential dependent affinity bio reactions such as in DNA based biosensors Impedimetric measurement advances the understanding of electrochemical behavior on electrode-electrolyte interface where parameters such as charge transfer resistance (Rct) and solution resistance.(Rs) were easily extracted from the modelled equivalent circuit Impedimetric technique was used in

the label less antibody-antigen reactions namely amyloid beta (a biomarker for Alzheimer's) and prostate specific antigen (PSA) biosensors (Figure 2).

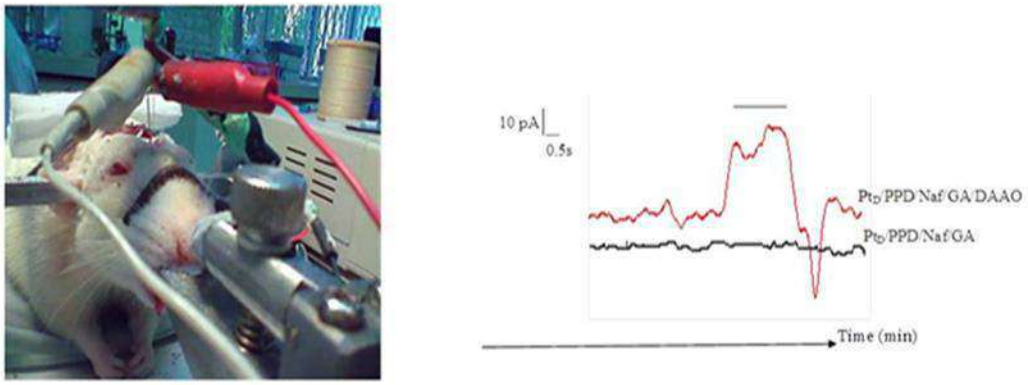
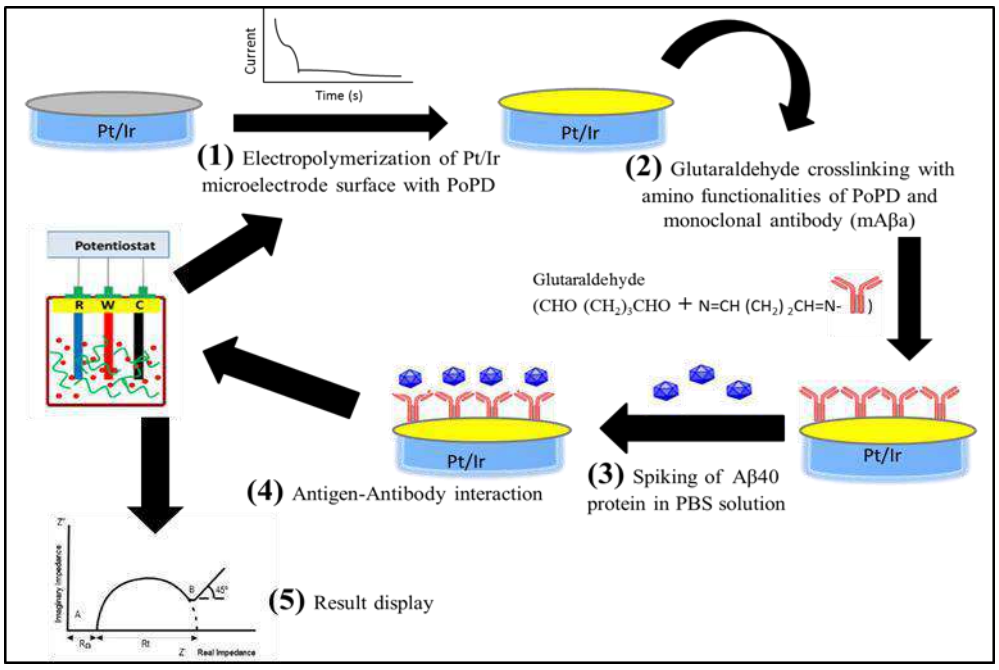


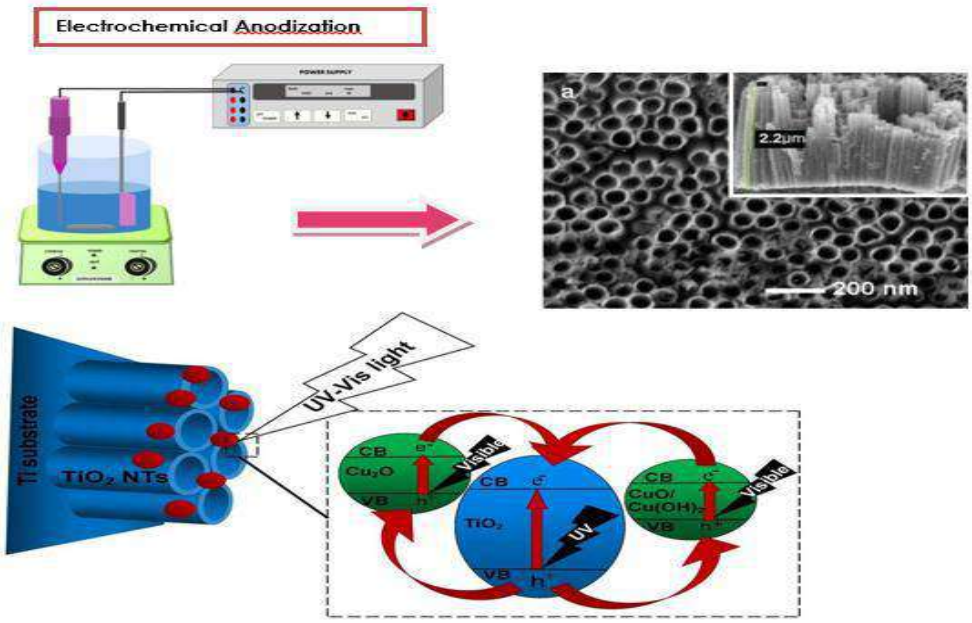
Figure 1. Temporal response of the sensor probe during in vivo detection of neurochemical in rat striatum. Bar indicates 5µL of 100 mM neurochemical microinjection beside the implanted sensors.



19.2.3 One Dimensional Metal Oxide via Anodization

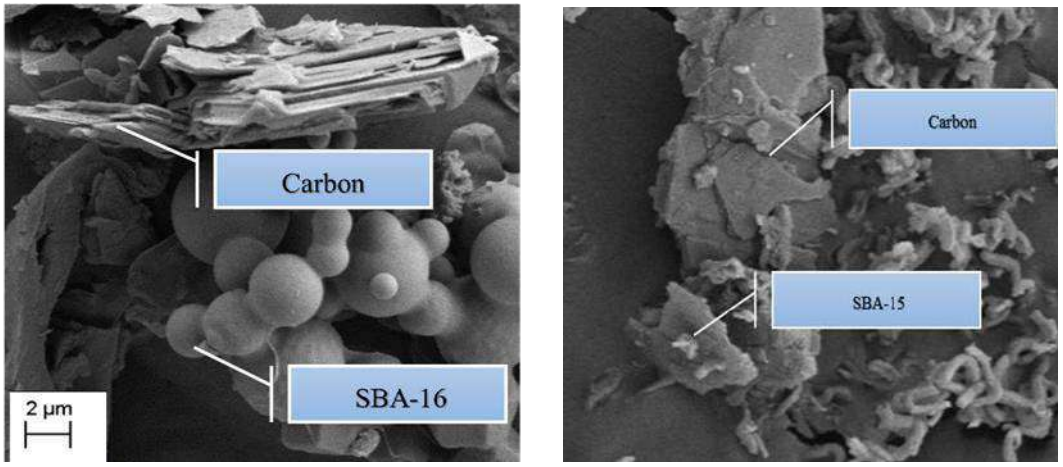
Electrochemical anodization can be defined as a controlled electrochemical growth of an oxide film on a metal substrate by polarizing the metal anodically in an electrochemical cell. Anodization can be conducted: (i) by potentiostatic mode (ii) by imposing constant current; galvanostatic mode, or (iii) by sweeping the anode potential at given rate; potentiodynamic mode. Anodized TiO_2 with well-aligned nanotubular structure provides unique electronic properties, such as high electron mobility, high specific surface area, excellent ability to harvest sunlight, and high mechanical strength. Furthermore, vectorial charge transport along the nanotubes to the collecting electrode facilitates the photoelectrochemical properties and photocatalytic efficiency, rendering TiO_2 nanotube arrays as a promising candidate

for multifunctional applications such as pollutant decomposition, photoelectrochemical water splitting and dye-sensitized solar cell



19.2.4 Electrochemical of Ordered Silica Mesostructure

The interest for the electrochemist of mesoporous silica, as either powder, hybrid membrane or a thin film, arises from the intrinsic properties of these materials. There are a range of structures depending on the application, including hexagonal (1D regular hexagonal packing of mesopore channels), cubic (3D bicontinuous systems of pores) and lamellar (2D system of silica sheets interleaved with surfactant bilayers). Moreover, porous silica is stable at high temperatures and is insoluble in most organic solvents. It also has a rigid structure with a negatively charged lattice above the isoelectric point (IEP = pH 2) with a wide range of pore sizes. The connection between electrochemical science and the chemistry of porous silica materials is the ability of electrochemical techniques to manipulate redox-active species to diffuse into porous cavities. Several electrochemical effects can be observed. The current responds to the charge species during the diffusion process, which in turn corresponds to the process of adsorption, complexation, catalytic behaviour or mass transport within the silica cavities. The properties of the porous materials become the main driving force and have been extensively exploited in electrochemistry via several advanced applications.



19.2.5 Micro Electro Mechanical Systems for BioSensor Technology

MEMS is a technique of developed a device and structure using microfabrication technology. It is applied in various field of applications such as temperature, pressure, inertial forces, chemical species, magnetic fields, radiation, etc. Recently MEMS has embarked its used as microsensors and microactuators. Microsensors converts mechanical signal into electrical signal. These conversion has many beneficial in human daily life such as building management systems, detection of molecular manufacturing clean rooms, microphones etc. The most recent application on MEMS is in medical field as biosensor such as to detect the hybridization of DNA. MEMS is manufactured and fabricated in microdimension measurements to detect the hybridization on the single-stranded DNAs. Various methods of measurement can be used and the most popular is electrochemical cyclic voltammetry. The redox reaction activities on the electrons movement will be detected and converted into the current microampere and nanoampere units.

19.3 Group Information and Background of Members

Name of RIG	**Electrochemical Materials and Sensors Group (EMSG)**
Leader	Dr. Lim Ying Chin
Tier	5
RIG Code	CoRe120/T5/2016(25)/FMIA(18)
Registration Year (Senate Approval)	2016
UiTM Niche Area	Chemical & Advanced Materials
RIG Niche Area	Sensors (impedimetric, chemical, biosensors) Conducting material (electrode ink) Electrodeposition of material (catalytic, corrosion inhibitor) Corrosion technology Nanomaterials (titanium dioxides, zinc oxides) Photocatalysis Anti microbial coating


UNIVERSITI TEKNOLOGI MARA
Electrochemical Material & Sensor
EMaS
Assoc. Prof. Dr. Zainiharyati Mohd Zain
Faculty of Applied Sciences
UiTM Shah Alam
limyi613@salam.uitm.edu.my
BACKGROUND
• PhD. Electroanalytical Chemistry, Universiti Sains Malaysia (USM)
• M Sc. Chemistry, Universiti Sains Malaysia (USM)
• B Sc. (Hons) Industrial Chemistry, Universiti Sains Malaysia (USM)
305
Citation
9
H-Index
NICHE AREA: SENSORS
RESEARCH INTEREST
• Chemical sensors, Biosensors
• Optical sensors
• Conducting polymers
EXPERTISE
• Sensor fabrication
• Analytical performance
• Impedance spectroscopy
• Real time neurochemical monitoring
TEACHING EXPERIENCE (YEARS)
20
SUPERVISION
On-Going
2 MSc
1 PhD
Graduated
5 MSc
1 PhD
RESEARCH GRANT
6 NATIONAL
2 INTERNATIONAL
1 INDUSTRY
PUBLICATION
INDEXED ARTICLES
20
NON INDEXED ARTICLES
6

Universiti Teknologi MARA — Electrochemical Material & Sensor — EMaS

Associate Professor Dr Yusairie Mohd
Faculty of Applied Science
UiTM Shah Alam.
yusairie@salam.edu.my

BACKGROUND
- PhD. Electrochemistry, Southampton University, UK

189 Citation | 7 *H*-Index

NICHE AREA: SURFACE COATINGS, ELECTROCATALYSIS, ANTIMICROBIAL COATINGS, CORROSION PROTECTION

RESEARCH INTEREST
- Surface Coatings
- Colloidal Nanoparticle (Silver & Gold)
- Corrosion Protection

EXPERTISE
- Electrodeposition by Cyclic Voltammetry, Chronoamperometry, Chronopotentiometry
- Corrosion Rate Measurement

TEACHING EXPERIENCE (YEARS) 23

SUPERVISION
On-Going
- 2 PhD
Graduated
- 3 PhD
On-Going
- 1 MSc
Graduated
- 6 MSc

RESEARCH GRANT
- 11 NATIONAL
- 4 UNIVERSITY

PUBLICATION

INDEXED ARTICLES	NON INDEXED ARTICLES
36	10

Universiti Teknologi MARA — Electrochemical Material & Sensor — EMaS

Dr. Lim Ying Chin
Faculty of Applied Sciences
UiTM Shah Alam
limyi613@salam.uitm.edu.my

BACKGROUND
- PhD. Materials Chemistry, Universiti Putra Malaysia (UPM)
- M Sc. Chemistry, Universiti Teknologi Malaysia (UTM)
- BSc. (Hons) Chemistry, Universiti Teknologi Malaysia (UTM)

70 Citation | 5 *H*-Index

NICHE AREA: PHOTOELECTROCHEMISTRY

RESEARCH INTEREST
- Surface modification of 1D nanomaterial
- Photoelectrochemical material
- Photocatalysis

EXPERTISE
- Electrochemical self-assembly process
- Metal doping of titania nanotubes
- Photoelectrochemistry

TEACHING EXPERIENCE (YEARS) 15

SUPERVISION
On-Going
- 1 MSc
- 1 PhD
Graduated
- 1 MSc

RESEARCH GRANT
- 2 NATIONAL
- 2 UNIVERSITY

PUBLICATION

INDEXED ARTICLES	NON INDEXED ARTICLES
20	6

UNIVERSITI TEKNOLOGI MARA

Electrochemical Material & Sensor
EMaS

Dr. Low Kim Fatt
Faculty of Applied Sciences
UiTM Cawangan Perak, Kampus Tapah
lowkimfatt@perak.uitm.edu.my

37 Citation | 4 *H*-Index

BACKGROUND

- PhD. Medical Biotechnology, Universiti Sains Malaysia (USM)
- BSc. Biomedical Sciences, Universiti Putra Malaysia (UPM)

NICHE AREA: BIOSENSING TECHNOLOGY

RESEARCH INTEREST

- Electrochemical biosensing
- Rapid detection of food contaminants
- Diagnosis of infectious diseases
- Surface modification

EXPERTISE

- Electrochemical analysis
- Synthesis of nanomaterials
- Thermostabilization technology
- Fabrication of lateral flow dipstick

TEACHING EXPERIENCE (YEARS)

4

SUPERVISION

On-Going: 1 MSc

Graduated: 1 PhD

RESEARCH GRANT

4 NATIONAL

3 UNIVERSITY

PUBLICATION

INDEXED ARTICLES: 7

UNIVERSITI TEKNOLOGI MARA

Electrochemical Material & Sensor
EMaS

Dr. Mohammad Noor Bin Jalil
Faculty of Applied Science
UiTM Shah Alam.
moham423@salam.uitm.edu.my

1 Citation | 1 *H*-Index

BACKGROUND

- PhD. Chemistry, University of Manchester, UK
- MSc. Universiti Teknologi Malaysia
- BSc.(Hons) Universiti Teknologi Malaysia

NICHE AREA: ELECTROCHEMISTRY OF ORDERED SILICA MESOSTRUCTURE

RESEARCH INTEREST

- Ordered Mesostructure Silica
- Surface Charge and Sensor
- Catalyst
- Corrosion Science
- Analytical Chemistry

PUBLICATION

1 BOOK

TEACHING EXPERIENCE (YEARS)

12

SUPERVISION

On-Going: 1 MSc

Graduated: 3 MSc

RESEARCH GRANT

1 NATIONAL

4 UNIVERSITY

PUBLICATION

INDEXED ARTICLES: 5

NON INDEXED ARTICLES: 1

20.0

FOOD PROCESS AND ENGINEERING RESEARCH GROUP

Siti Noor Suzila Bt Maqsood ul Haque, Habsah Alwi, Nurul Asyikin Md Zaki, Ummi Kalthum Ibrahim, Siti Fatma Abd Karim, Nor Khaizan Anuar

20.1 Introduction

Food Process and Engineering research group is formed to foster research on food processing and engineering application when subjected to various types of food products. Pharmaceutical is essential as it is needed in the application part of the final process formulation.

Many activities emphasize on the following areas:

1. Mathematical design and analysis of drying on food products using different type of methods for example, infrared microwave, oven and spray drying.

2. Development of a new smart and intelligent packaging film for agricultural products.

3. Invention on alternative natural colour additives in food processes.

4. Development on edible pharmaceutic film for wound healing purposes.

5. Invention of fiber enriched milk tablet targeting constipation problem among children.

Knowledge and technology transfer to clients includes guidelines, problem solving and industrial process designs.

20.2 Research Highlights

20.2.1 Fiber Enriched Milk Tablet

Child's diet during his/her early year of life depends greatly on milk consumption. In order to increase the fiber intake, fiber enriched milk tablet is the best solution for this problem. Hence, parents do not have to blend puree fruits or boiled vegetable to be given to the children. This product can save time, easy and manage and convenient for working parents. The novelty of this product is that fiber based milk tablet without additives is a new discovery and has not been commercialized and this product also provides an alternative source of fiber in the milk consumption. This research won a Gold medal at IIDEX 2016.

20.2.2 Pure Shades

Colour is the first observable characteristics of food for consumer to judge the quality of food. Food colour additives that are widely used in food product currently originates from synthetic sources and many lead to potential harm like cancer in the future if it's being consumed for a long period of time. The purpose of this research is to produce a natural safe edible food colouring additives. Few potential natural colour addtives had been extracted from purple cabbage, dragon fruit, spinach, bunga telang and pumpkin to give different colour hues to the food product. This research won a Silver medal at IIDEX 2017.

20.2.3 Mask Film

The use of food-grade industrial waste as a source of polymeric material promising more economical packaging with biodegradable properties. A new active and smart packaging film was developed by using soft-gel capsule waste (SCW) from nutraceutical industry incorporated with sago starch (SS) and Brassica oleracea (Red cabbage) extract from agricultural waste. The soft-gel capsule waste and sago starch are the source polymeric materials while the red cabbage extract (RCE) as the source of natural antioxidant and pH-sensitive pigment. Before development of biodegradable films, the main component such as of soft-gel capsule waste (SCW) and purified soft-gel capsule (PSC) were identified. The presence of anthocyanin pigment as natural pH sensitive dye also was detected in the red cabbage extract. The films based on food-grade waste has the potential to be used as an antimicrobial and visual indicator of the pH variation to preserve the quality of food and detect the food spoilage. This research has won Bronze medal at IIDEX 2017.

20.2.4 Freeze Dried Tamarind Powder

Tamarind is an indigenous plant of Tropical Africa which is a slow growing but long lived, highly wind resistance, with height of 80 to 100 ft. Tamarind specifically known as *Tamarindus Indica L.* is valued most for its multipurpose fruit and pulp which are widely used for its application in domestic and industrial sector. Tamarind pulp has been commercialised widely in the market in the form of paste to be used in variety of dishes as it adds a tangy and piquant lift to the cooking. Besides, tamarind pulp possesses high amount of antioxidant due to the high phenolic content. Currently, tamarind extract has been

commercialised widely in the market in the form of paste or pulp to be used in variety of dishes as it adds a tangy and piquant lift to the cooking. The tamarind fruit is customarily used in paste form. Somehow, there is a need in converting tamarind pulp in the form of powder which can prove more benefit such as low water activity hence, longer shelf life, and ease in handling, transport and storage of the product. Since tamarind is rich in benefits, tamarind products need to be developed and explored to widen the usage of the fruit. Freeze dryer was used to produce tamarind powder from tamarind pulp since it operates without heating or boiling hence, preventing thermal damage and loss of sensitive compounds. Despite the high operating cost of spray drying, this method has the ability to protect sensitive compounds like nutritional component, appearance, colour and texture In order to reduce the stickiness and produce free-flow tamarind powder, maltodextrin is introduced as drying aid for tamarind powder produced by freeze drying process. This research will be presented at IIDEX 2019.

20.2.5 Green Coffee Bean (GCB) as Functional Ingredient

Green coffee contains a large quantity and variety of polyphenols and flavonoids. This project focused on Chlorogenic acids from green Arabica coffee beans extract. The composition of the polyphenols in coffee, due to the formation of compounds generated by Maillard reaction, which have antioxidant, antimicrobial and anti-inflammatory potential.

Green Coffee Bean

Green Coffee Bean Powder

Incorporation of GCB in Health Care Product

Inflammatory skin illnesses are the most well-known issue in dermatology. This type of illness has been known one of the biggest illness in Malaysia for the past few years. Chlorogenic acids also has been proven to exhibit antibacterial activity on pathogenic bacteria. Thus, in this project shows the reliability on Green Coffee Bean oils extracted using Soxhlet extraction to be applied in personal health care product such as soap for the anti-inflammatory effect and hand sanitizer for antimicrobial effect. Evaluation on antimicrobial effect of developed soap and hand sanitizer were conducted by using disc diffusion method against *Escherichia Coli*. Zone inhibition of *E. Coli* was observed when using green coffee beans extract. As a conclusion, due to the rich of bioactive compound (Chlorogenic acids), green coffee bean has the potential new functional ingredients not only for human health, but also to the pharmaceutical and cosmeceutical industries. This research will be presented at IIDEX 2019.

Soap incorporated with GCB

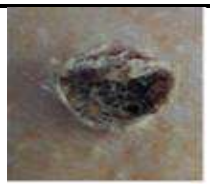
Incorporation of GCB in Bread

Bread incorporated with green coffee beans research has been carried out to evaluate the antioxidant, total phenolic content, antimicrobial properties, quality parameters (volume, moisture content, colour, and texture of the bread) and sensory evaluation analysis. The outcome from this research showed that the addition of GCB had significantly improved the total phenolic content and antioxidant activity of bread as well as increase the quality of the bread itself. Moreover, incorporation with GCB also exhibits strong antimicrobial properties and acceptable differences in appearance, aroma, taste, and texture of the bread. This research has been published in journal and conference proceedings.

Bread incorporated with GCB

20.2.6 Pectin Hydrogel Wound Dressing

This project focused on the development of 'Pectin Hydrogel Wound Dressing' for partial thickness burn wound. Pectin is an effective wound healing agent by itself. Commercial pectin is usually extracted from citrus peels and apple pomace; both are by-products of fruit juice industry. 'Pectin Hydrogel Wound Dressing' offers an alternative to the advanced wound care market using cheap and renewable material. The dressing was designed to keep the wound moist, able to absorb drainage of blood or wound exudates, and maintain an acid environment which acts as a barrier against bacteria. This research won a Silver medal at IIDEX 2017.

Day/Rats	Control (untreated)	Treated by pectin hydrogel
0		
2		
7		
14		

20.3 Group Information and Background of Members

Name of RIG	Food Process And Engineering Research Group
Leader	Dr Siti Noor Suzila Bt Maqsood ul Haque
Tier	5
RIG Code	CoRe108/T5/2016(13)/FMIA(17)
Registration Year	2018

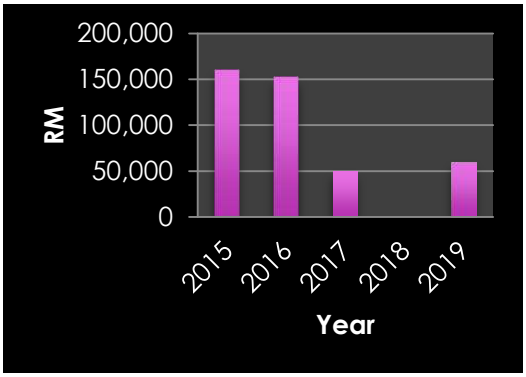
(Senate Approval)	
UiTM Niche Area	Frontier Materials Science & Engineering
RIG Niche Area	Food Engineering

	MEMBERS	FACULTY	QUALIFICATION	NICHE
	*Dr Siti Noor Suzila bt Maqsood ul Haque*	Faculty of Chemical Engineering Staff ID: 310295	PhD	Food Engineering
	*Dr Ummi Kalthum bt Ibrahim*	Faculty of Chemical Engineering Staff ID: 222985	PhD	Food Engineering
	*Nurul Asyikin Md Zaki*	Faculty of Chemical Engineering Staff ID: 256760	Master	Food Engineering
	*Habsah Alwi*	Faculty of Chemical Engineering Staff ID: 239172	Master	Food Engineering
	*Siti Fatma bt Abd Karim*	Faculty of Chemical Engineering Staff ID: 309633	Master	Food Engineering
	*Dr Nor Khaizan Bt Anuar*	Faculty of Chemical Engineering Staff ID: 287412	PhD	Pharmaceutics

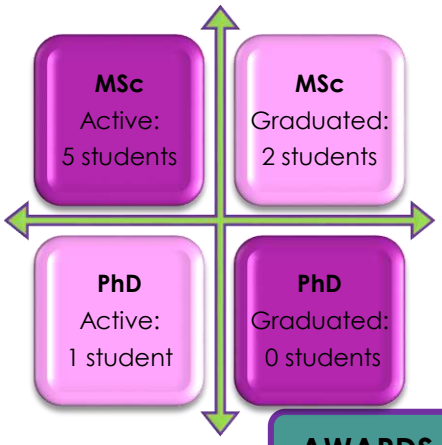
Achievement (2015-2019)

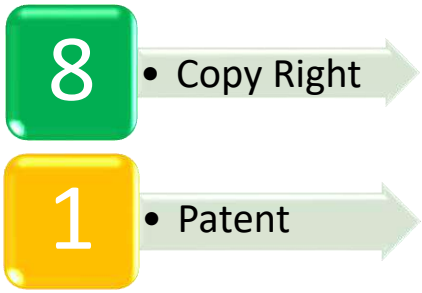
GRANTS OBTAINED

PUBLICATIONS

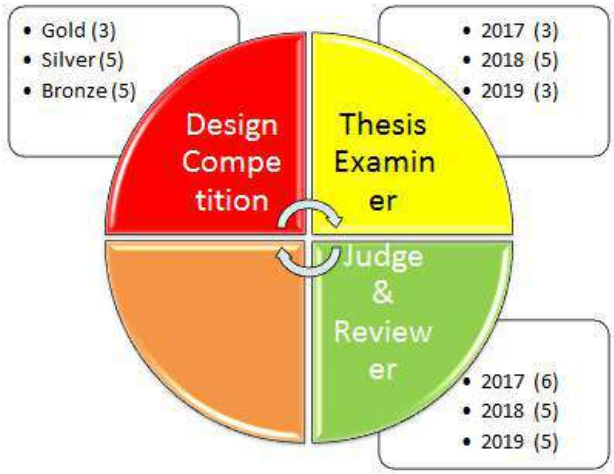


POSTGRADUATE SUPERVISION





AWARDS AND RECOGNITION



21.0

MOLECULAR SELF-ASSEMBLY TECHNOLOGY

Nurul Fadhilah Kamalul Aripin, Nornizar Anuar, Tan Huey Ling, Siti Nurul 'Ain Yusop, Sakinah Mohd Alauddin, Muhamad Fitri Othman, Hairul Amani Abdul Hamid, Farah Hanim Ab Hamid

21.1 Introduction

The Molecular Self-Assembly Technology research group is consolidated by like-minded researchers investigating on fundamental studies of molecular self-assembly behavior in order to discover unique structure-property relations. This would lead to improved physicochemical properties for the development of new materials.

Our researches focus on the following areas:

1. Mesogenic material – Synthesis of liquid crystalline material (mesogens) primarily, biosurfactant and functional liquid crystal polymers. Studies on the physicochemical properties i.e. phase behavior, molecular dynamics, physical interactions, functional behavior.

2. Crystals – Studies involving solvent selection, solubility, nucleation kinetics and crystal growth rate assessment. Multiscale molecular modelling of molecule, dimers, clusters, surface chemistry and interfacial behaviour, structure and polymorphism.

3. Peptide research – Investigations of membrane active peptides (antimicrobial, cell penetrating), membrane biophysics (fluorescence, small angle X-Ray), nanotechnology and biosensor. Also includes waste valorization (separation and extraction of food by-product).

4. Separation process – Studies of separation process using progressive freeze concentration involving formation of crystals.

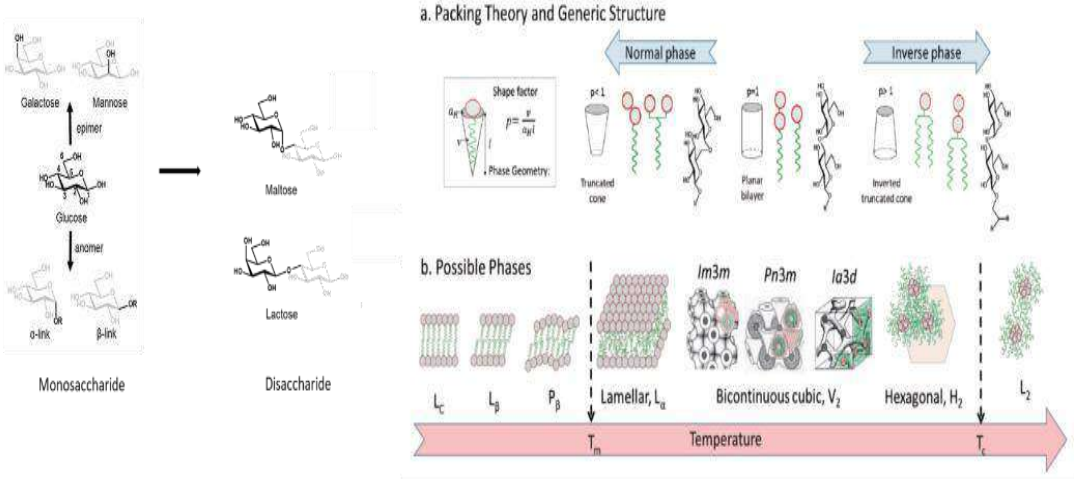
21.2 Research Highlight

21.2.1 Liquid crystals

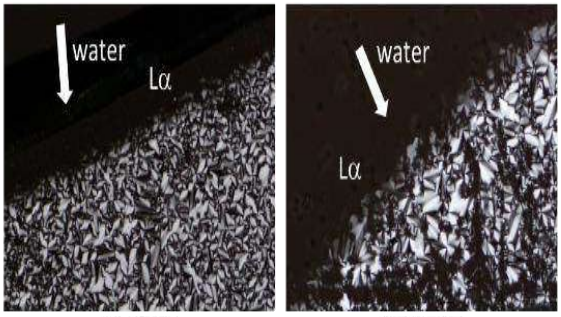
Glycosides

Glycosides consist of a sugar head group and an alkyl chain attached to the anomeric carbon via the glycosidic bond. The glycosides display amphitropic behaviour which they can self-assemble into several polymorphic forms in dry (thermotropic) and solvated (lyotropic) conditions. These polymorphic forms such as micelles and vesicles can vectorise hydrophilic and lipophilic drug, thus, making glycosides as great candidate for targeted drug carrier system. The presence of sugar head group allows interactions between sugar head group and cell receptors,

enabling specific binding accessibility to targeted sites. For this purpose, it is important to understand the physicochemical properties of the glycolipids. Our project investigates monoalkylated glycosides synthesized from palm oil and their thermotropic and lyotropic properties have been characterised to determine their potential in pharmaceutical and biological applications.

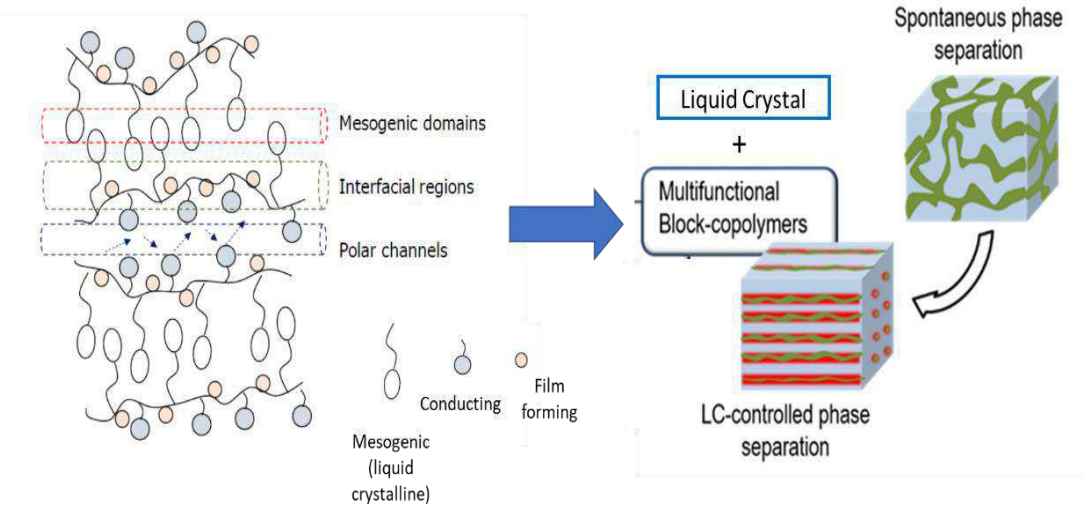


Hashim, R., et al. (2018). "Dry Thermotropic Glycolipid Self-Assembly: A Review." J Oleo Sci **67**(6): 651-668.



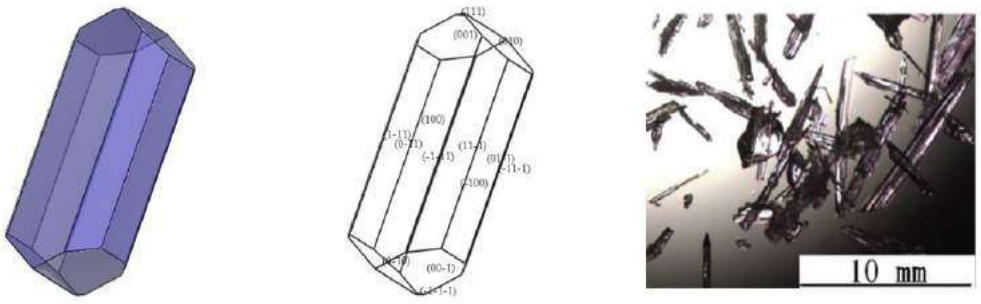
Liquid crystal polymer membrane

Low temperature fuel cells are a promising technology for renewable and environmental-friendly power source. However, drawbacks in the fuel cell occurs when unreacted methanol permeates through the fuel cell membrane resulting in low proton transport which reduces cell efficiency with a loss of up to 55%. Therefore, membrane modification by tailoring the morphology of the membrane via block or random copolymerization and incorporation of liquid crystal and additives is an effective approach to provide selective ion transport in the membrane and overcome this problem. The construction of these new membrane material and a simplistic yet versatile method for the production of low temperature fuel cell membrane will greatly contribute to the electrical and electronic industry.

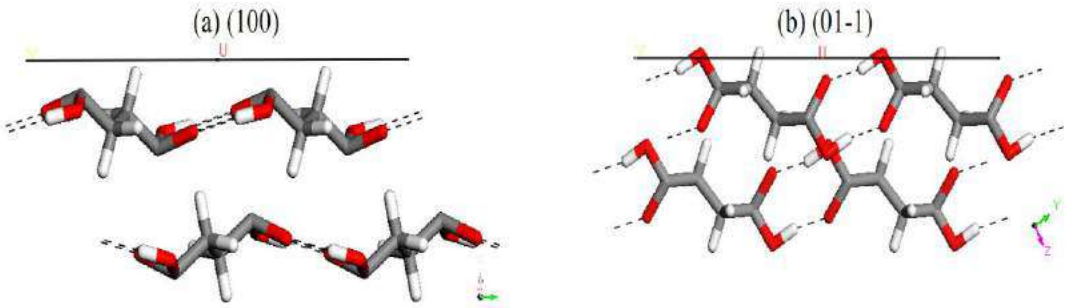


21.2.2 Morphology Prediction and Dissolution Behavior of α-Succinic Acid in Ethanol Solution Using Molecular Dynamic Simulation

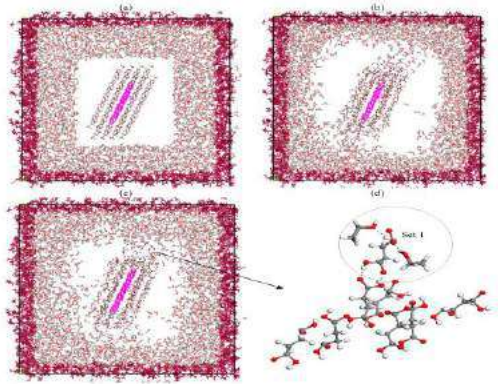
Succinic acid is a potential co-former to produce co-crystal, thus an understanding of the dissolution behaviour of succinic acid crystal is crucial for designing the co-crystal. In this works, α-succinic acid was chosen as a model compound due to its attractive crystal chemistry and its diverse surface properties. The aims of this study are to analyse the morphology of α-succinic acid crystal and its dissolution behaviour in ethanol solution using molecular dynamic simulation. Prediction of α-succinic acid morphology were conducted with different combination of Electrostatic Potential (ESP) charge set and Consistent Valance force field (CVFF) which produces hexagonal needle-like shape morphology and shows good agreement with the experimental crystal shape. Dissolution of α-succinic acid in ethanol solvent was investigated using dynamic simulation. Visual observation and mobility assessment shows that the molecules at the edge of the crystal tends to dissolve faster compared to the molecules at other position on the facet.



(a) Simulated crystal morphology obtained from Material Studio with habit facet. (b) Simulated crystal morphology with facet (h k l) and (c) α-succinic acid crystal grown in water.



Molecular packing structure of α- succinic acid demonstrating the surface chemistry of crystal facet: (a) (100), (b) (01-1)



Snapshots configuration of simulation boxes, dark red and pink in color are constrain molecule, (a) image at 0 ps (b) image at 50 ps (c) image at 100 ps (d) enlarged image of 100 ps show the α-succinic acid (set 1) – ethanol H-bond.

21.2.3 Antioxidant activity of Carica papaya leaf (CPL) and Garcinia mangostana pericarp (GMP)

Carica papaya leaf (CPL) and Garcinia mangostana pericarp (GMP) are common medicinal plants used in complementary medicine for their antioxidant, anti-inflammatory, immunomodulatory properties and antiviral properties. In the absence of effective drug therapy for dengue treatment, CPL has been recognized as potent anti-dengue therapy by numerous studies. In this study, natural fermentation was carried out to improve the antioxidant activity of two indigenous medicinal plants; CPL and GMP. Natural fermentation was selected to mimic the biodiversity of colonic microbiota (rather than starter culture method commonly used in existing medicinal plants fermentation). Natural fermentation has successfully enhanced the antioxidant activity of GMP and CPL by two and four times respectively as compared to their unfermented, water suspension. They also displayed higher antioxidant activity as compared to other plant extracts. The prevalence of LAB e.g. Lactobacillus plantarum and Lactobacillus pentosus as well as yeast e.g. Pichia kudriavzevii and Hanseniapora meyeri during natural fermentation of GMP and CPL elucidated their

potential use as starter culture for a more refined, controllable and safe process in future.

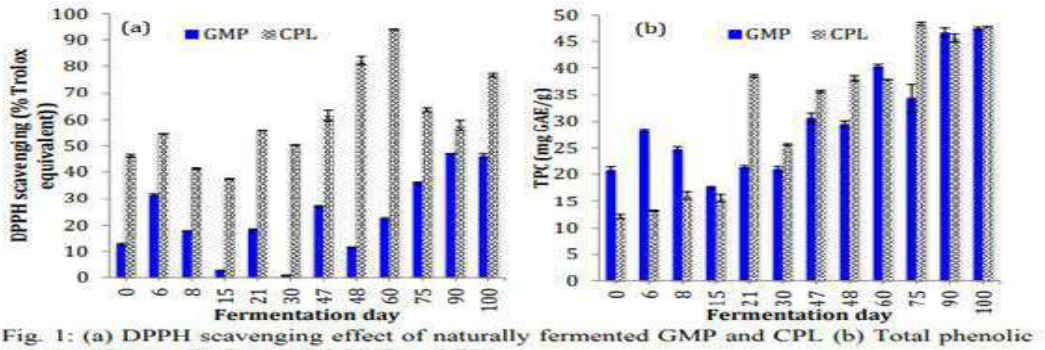


Fig. 1: (a) DPPH scavenging effect of naturally fermented GMP and CPL (b) Total phenolic content of naturally fermented GMP and CPL.

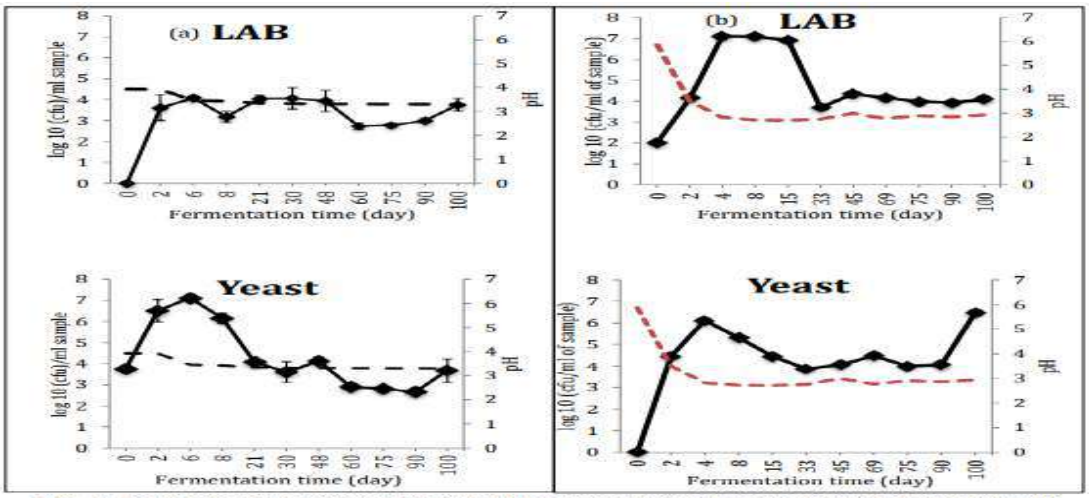


Fig. 2: Population dynamics (solid line) of microorganisms during natural fermentation of (a) GMP and (b) CPL. pH (dashed line).

21.2.4 Glycolipids Derived from In Vitro Culture of Malaysian Aromatic Rice (Oryza sativa L. Cv. MRQ74)

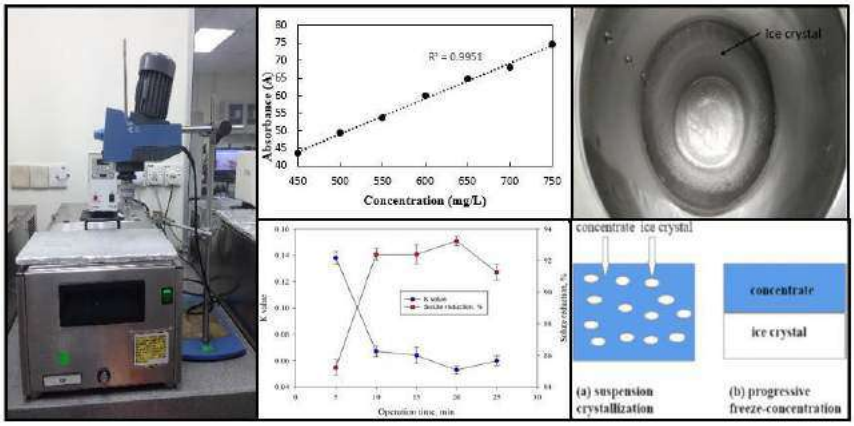
Cell membranes contain glycolipids which are carbohydrate attached lipids. These glycolipids can be divided into categories namely natural and synthetic glycolipids. Natural glycolipids are particularly important class of membrane components because they are involved in intercellular recognition processes as they are found in the exterior of the lipid layer of cell boundaries. However, synthetic glycolipids are classified into two sub-groups. The first sub-group is the constituent analogues of naturally occurring membrane lipids such as diacyl glycoglycerolipids. These have become the focus of phase studies since late 1980s. The second sub-group with single alkyl chain that called sugar-based surfactants is alkylpolyglycosides (APGs) that becomes important in industrial view as environmentally friendly surfactants. Moreover, the glycolipids can be synthesized from renewable sources like oligosaccharides and fatty alcohols; they become less environmentally damaging than other synthetic surfactants. However, most of the glycolipid based products nowadays are from synthetic glycolipids. Therefore, the research on glycolipids derived from in vitro culture of Malaysian aromatic rice (Oryza sativa L. Cv. MRQ74) which is an aromatic rice cultivar selected from a cross involving Q34, KDML 105 and

Kasturi is conducted. Further research need to be done to this species in order to explore more its potential applications such as in emulsions, cosmetics and pharmaceutical industries. These may give significant benefits in agricultural and also in industrial applications. Hence, this research is in line with the one of NKEAs which is agricultural sector.

21.2.5 Separation using Progressive Freeze Concentration

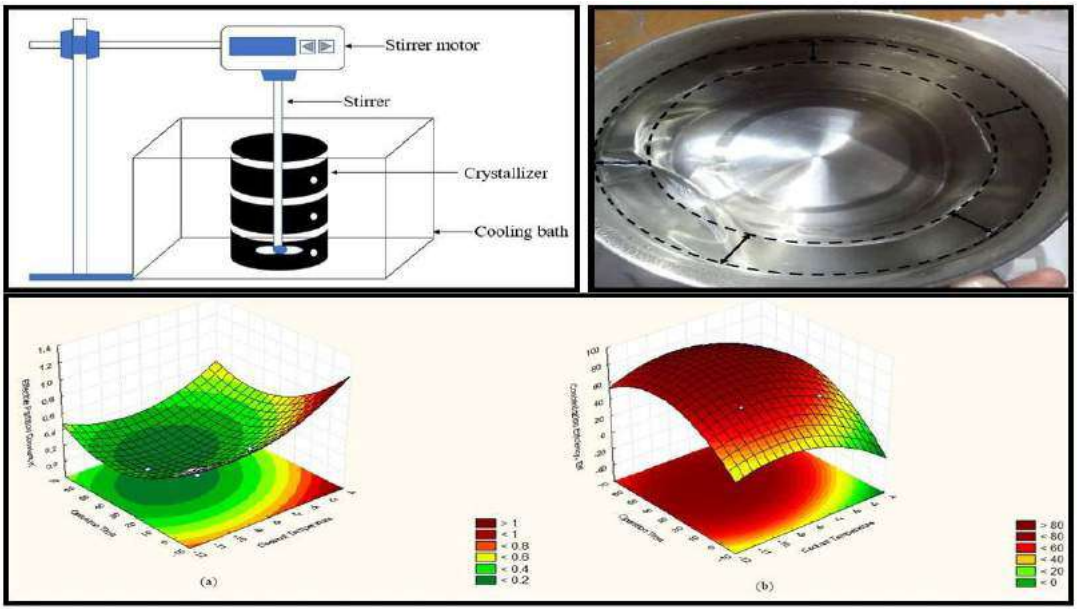
Methylene Blue Removal from Dye Wastewater via Progressive Freeze Concentration

Dyeing is an important process in many manufacturing industries mainly in textile, food, plastic, paper and cosmetics. Despite the impressive growth rate of dye industries, to-date, public are not aware that this industry is harmful to the environment. Dye manufacturing processes produced massive amount of wastewater and liquid effluents, which contains high toxic of organic residues with major compounds of phenol derivatives, aniline derivatives, organic acid and benzene derivatives. Progressive freeze concentration (PFC) is the most recent potential technology for dye wastewater treatment. In principle, PFC operates based on the solidification phenomena of water, where the water is removed from solutions by freezing it up to the formation of ice crystals, followed by a separation process to separate the ice crystals from the concentrated solution. In the present work, PFC was applied to purify simulated dye wastewater focusing on coolant temperature, operation time and stirring speed. The objective of this study is to investigate the mentioned parameters on the efficiency of PFC by considering the effective partition constant (K) and the percentage of solute reduction in ice.



Optimization of progressive freeze concentration on stormwater purification via response surface methodology

Shortage and lack of sources of clean water is a big issue nowadays. This problem happens because of the increment of population that leads to the amount of water usage increase at an alarming rate. Therefore, the sources of water must be explored in order to get a continuous supply of clean water. This study recommends a new approach to get clean water which is by purifying the stormwater via progressive freeze concentration (PFC). This method produces a single ice crystal block that contains high purity of water. This paper focuses on the optimization of two operating parameters which are coolant temperature and operating time. In order to determine the effectiveness of this technology, effective partition constant (K) and concentration efficiency (Eff) were examined. Response surface methodology (RSM) and central composite design (CCD) were implemented to find the optimum operating conditions via STATISTICA Software.



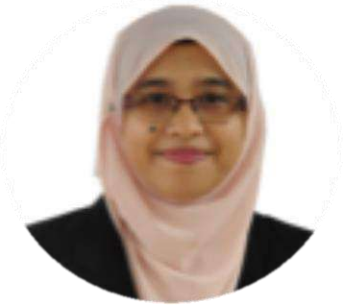
21.3 Group Information and Background of Members

Name of RIG	Molecular Self-Assembly Technology (MSAT)
Leader	Dr. Nurul Fadhilah Kamalul Aripin
Tier	5
RIG Code	CoRe156/T5/2018(5)/FMIA(27)
Registration Year (Senate Approval)	2018
UiTM Niche Area	Synthesis and characterization of functional materials
RIG Niche Area	Fundamental studies on molecular self-assembly to improve physicochemical properties of material aiming for specific applications in the pharmaceutic, biology and renewable energy industries.

DR NURUL FADHILAH KAMALUL ARIPIN
FKK
Liquid crystal, drug delivery system, functional liquid crystal polymer

DR NORNIZAR ANUAR
FKK
Crystallisation

DR TAN HUEY LING
FKK
Nanotechnology, Sensor, Membrane Active Peptide, Waste Valorization



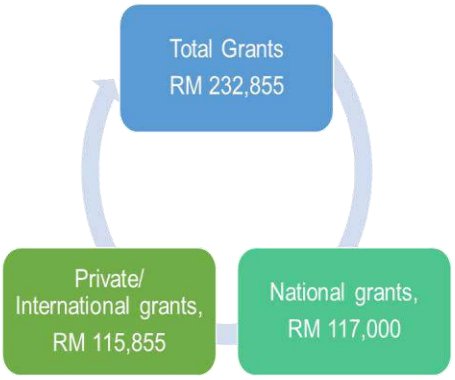
DR SITI NURUL 'AIN YUSOP
FKK
Crystallisation

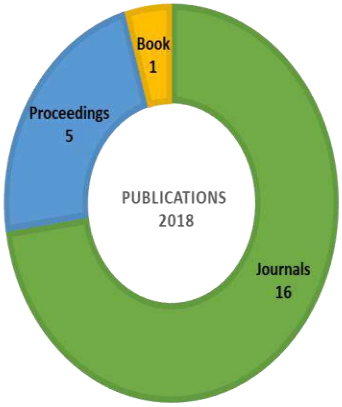
DR FARAH HANIM AB HAMID
FKK
Crystallisation, separation process

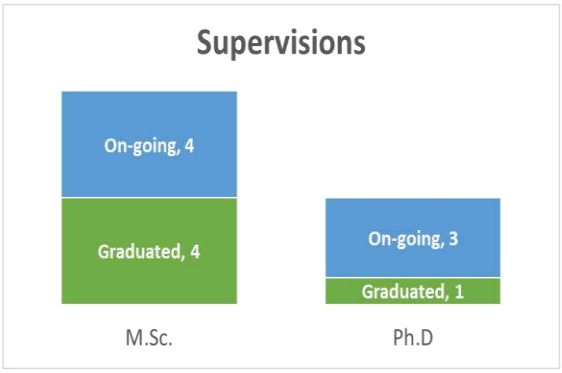
SAKINAH MOHD ALAUDDIN
FKK
Functional polymer, liquid crystal

MUHAMAD FITRI OTHMAN
FKK
Crystallisation

HAIRUL AMANI ABDUL HAMID
FSG
Liquid crystal, glycolipids







Design competition
- SRIIC 2017 - Gold
- IIEDEX 2017 - Bronze

Expertise recognition
- Awards - 2
- Judge & reviewer - 4

22.0

MEMBRANE TECHNOLOGY (MEMTEC)

Nur Hidayati Binti Othman, Norin Zamiah Kassim,Lim Ying Pei, Norhidayah Ideris,Meor Muhammad Hafiz Bin Shah Buddin, Asdarina Binti Yahya Pm Dr. Ramlah Mohd Tajuddin

22.1 Introduction

Membrane Technology research group is formed to encourage collaborative research related to membrane-based separations for various applications include wastewater treatment, gas separation, membrane contactors, catalytic reaction and sensor development. We have managed several research projects with national and international universities and industries such as Universiti Teknologi Malaysia (UTM), Universiti Sains Malaysia (USM), Sime Darby Plantation, Imperial College London (UK), Universitas Diponegoro (Indonesia) and Ege University (Turkey).

Many of our research activities emphasize on the following areas:

To carry out fundamental and applied research related to the membrane-based separations for various applications

To discover and fabricate new membrane materials and designs, and further develop fundamental understanding of the relationship between the membrane structure and its characteristic separation properties.

To carry out design study by modifying the membrane structure and morphology (blending, thin film deposition and in-situ functionalization) with an aim to search for optimal trade-offs, to solve the requirements of high flux and selectivity.

MEMTEC has an advanced membrane separation lab with a number of facilities such as single/mixed gas permeation test systems, nanofiltration dead-end and cross-flow test systems, photocatalytic test systems, emulsified liquid membrane test system and ceramic hollow fiber membrane spinning and polymeric casting machines, angle.

22.2 Research Highlights

22.2.1 Membrane technology for Oil and Gas Industry

Currently, oil and gas industry faces with difficult separation processes due to stringent environmental regulations. As a results, membrane technology can be considered as the excellent process solution proven to meet the industry demand. The membranes can be used for various applications such as production of high purity oxygen (to replace expensive cyrogenic distillation process), gas separation (removal of CO2 from natural gas) and for produced water treatment (removal of oil from wastewater).

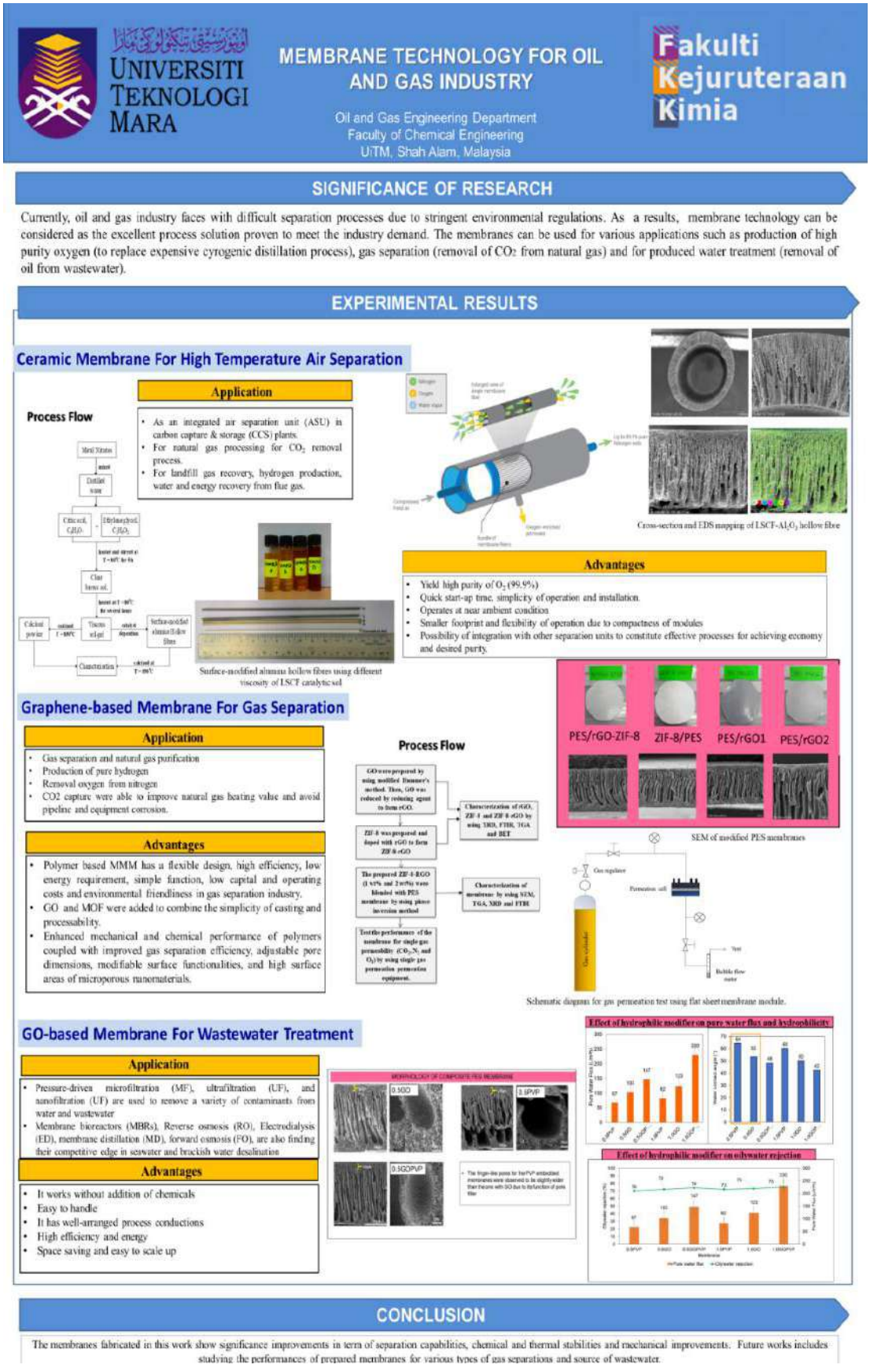


Figure 1. Membrane technology for oil and gas industry

22.2.2 Development of functional nanomaterials and mesaporous materials for membrane performances enhancement

Micro- or nano-size particles have been largely used as fillers to fabricate hybrid membranes, as they typically own a higher permeability and/or selectivity compared to polymeric materials, or their surface properties can enhance the transport of target gases. At the same time, their dispersion in the polymer matrix allows an easier exploitation of the properties of these phases, as purely inorganic matrix is typically very brittle and difficult to manufacture.

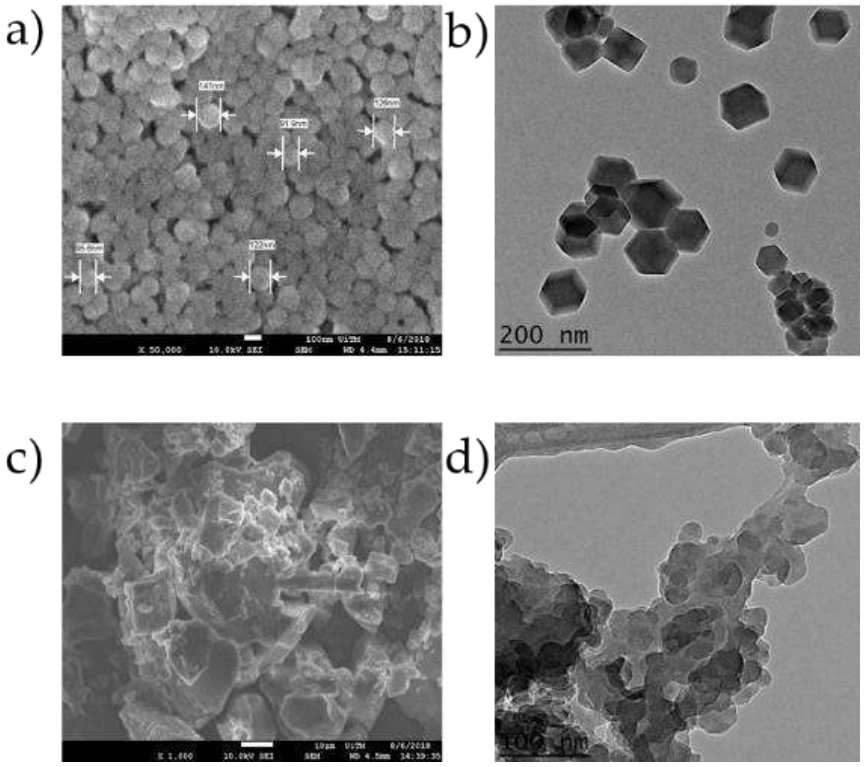


Figure 3 : rGO/ZIF-8 nanomaterials

22.2.3 Emulsion Liquid Membrane (ELM) is developed to reduce heavy metal content in wastewater

ELM is robust and can be easily formulated to remove many types of solute from aqueous solution. Complying the regulations on heavy metal content in water to be discharged is a challenging task. The formulation and stability of the membrane is currently the focus of the work to ensure maximum extraction of heavy metal from wastewater.

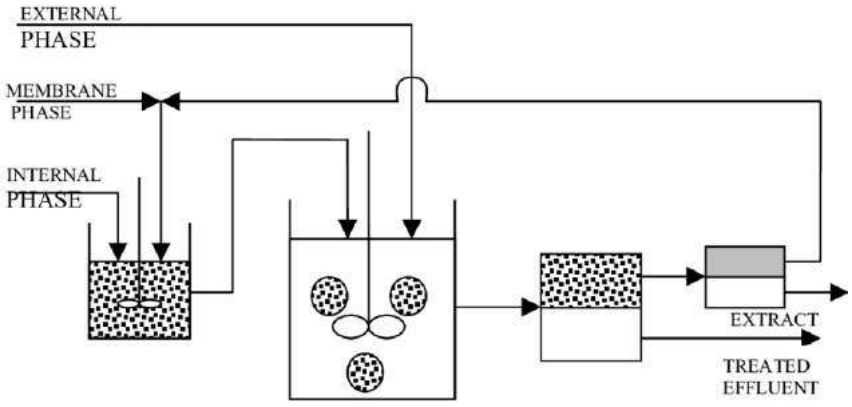


Figure 2 : Emulsion liquid membrane

22.2.4 Fabrication of Thin film composite with hybrid membrane as the barrier layer for heavy metal removal

Water scarcity is becoming the great challenge in the world recently due to the population growth, economic development and pollution. Heavy metals as water pollutant has created major problem due to its toxicity characteristics and non-biodegradability. Based on the recent findings, the fabricated thin film composite membrane is able to remove copper ion in the wastewater, where the final concentration is around 0.2 to 0.5 mg/L, which is within the acceptable limit of standard B of effluent discharge as outlined by the Environmental Quality (Industrial Effluent) Regulations 2009. The composite consists of hybrid membrane as the top thin layer, which is formed by a combination of at least two different polymer materials, usually inorganic and organic polymers. In the process of heavy metal ion removal, the use of thin film composite membrane represents the integrated complexation method, where the hybrid membrane acts as a barrier layer to form complexes with the heavy metal ion and retains on the membrane. So the water molecules could pass through the membrane

22.3 Group Information and Background of Members

Name of RIG	Membrane Technology
Leader	Dr. Nur Hidayati Binti Othman
Tier	5
RIG Code	CoRe170/T5/2018(19)/FMIA(28)
Registration Year (Senate Approval)	Oktober 2018
UiTM Niche Area	Separation
RIG Niche Area	Membrane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DR. LIM YING PEI
197243 ; FKK, UiTM Shah Alam
PhD (Chemical Engineering), UKM
Membrane separation, Wastewater Treatment, Photocatalysis
DR. NORIN ZAMIAH KASSIM
238351 ; FKK, UiTM Shah Alam
PhD (Mass Transfer-Oleochemicals), UiTM
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ASDARINA BINTI YAHYA
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DR. NORHIDAYAH IDERIS
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PhD (Chemical Engineering), USM
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MEOR MUHAMMAD HAFIZ BIN SHAH BUDDIN
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Membrane technology for wastewater treatment and separation
PM DR. RAMLAH MOHD TAJUDDIN
102160 ; FKA, UiTM Shah Alam
PhD (Civil Engineering), UTM
Wastewater, Membranes, Land Fill, Leachate
3

23.0

INTEGRATED SEPARATION TECHNOLOGY RESEARCH GROUP (i-STRonG)

Fauziah Marpani, Siti Wahidah Puasa, Ana Najwa Mustapa, Putri Nadzrul Faizura Megat Khamaruddin and Nur Ain Mohd Zainuddin

23.1 Introduction

The research group focuses on integrated separation process particularly on membrane application, supercritical fluid extraction and adsorption techniques. Research activities are mainly to discover new coupled processes as novel tools to enhance product development and chemical process with energy saving and environmental friendly feature. Emphasized will be directed towards process design study including fundamental and applied research in various applications.

Research Expertise

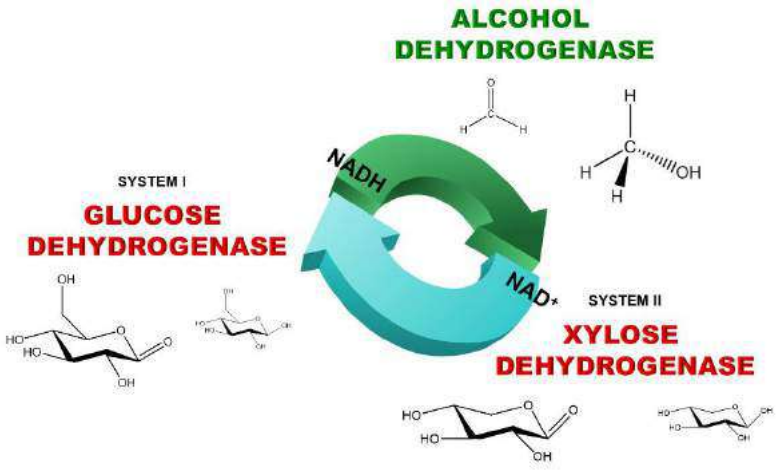
1. Reactive membrane filtration
   Enzyme technology integrated with membrane separation for simultaneous reaction and product separation
2. Supercritical Fluid Extraction
   Advanced, non-invasive extraction methods preserving natural constituents of product
3. Industrial Wastewater Treatment
   Certified Environmental Professionals in the Operation of Industrial Effluent Treatment (CePIETSO)
4. CO_2 Sequestration and Reduction
   Hybrid membrane development for CO_2 sequestration and reduction to useful basic chemicals

23.2 Research Highlights

23.2.1 Kinetics based reaction optimization of enzyme catalysed reduction of formaldehyde to methanol with synchronous cofactor regeneration

Enzymatic reduction of carbon dioxide (CO_2) to methanol (CH_3OH) can be accomplished using a designed set-up of three oxidoreductases utilizing reduced pyridine nucleotide (NADH) as cofactor for the reducing equivalents electron supply. For this enzyme system to function efficiently a balanced regeneration of the reducing equivalents during reaction is required. Herein, we report the optimization of the enzymatic conversion of formaldehyde (CHOH) to CH_3OH by alcohol dehydrogenase, the final step of the enzymatic redox reaction of CO_2 to CH_3OH, with kinetically synchronous enzymatic cofactor regeneration using either glucose dehydrogenase (System I) or xylose dehydrogenase (System II). A mathematical model of the enzyme kinetics was employed to identify the best reaction set-up for

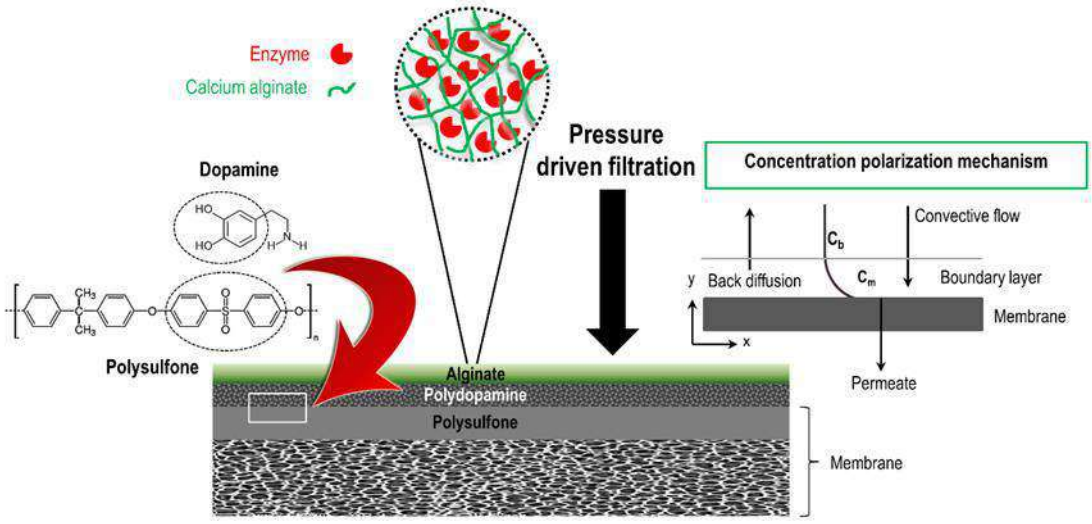
attaining optimal cofactor recycling rate and enzyme utilization efficiency. Targeted process optimization experiments were conducted to verify the kinetically modelled results. Repetitive reaction cycles were shown to enhance the yield of CH_3OH, increase the total turnover number (TTN) and the biocatalytic productivity rate (BPR) value for both system I and II whilst minimizing the exposure of the enzymes to high concentrations of CHOH. System II was found to be superior to System I with a yield of 8 mMCH_3OH, a TTN of 160 and BPR of 24 µmol $CH_3OH/U{\cdot}h$ during 6 hr of reaction. The study demonstrates that an optimal reaction set-up could be designed from rational kinetics modeling to maximize the yield of CH3OH, whilst simultaneously optimizing cofactor recycling and enzyme utilization efficiency.



23.2.2 *In situ* formation of a biocatalytic alginate membrane by enhanced concentration polarization

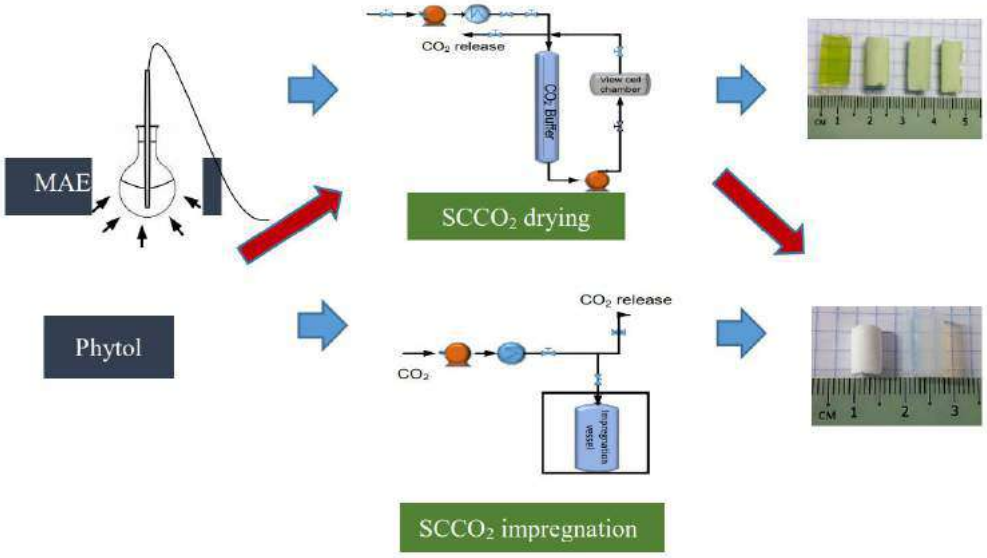
The concept of fouling-induced enzyme immobilization in combination with the effect of concentration polarization phenomenon was manipulated to entrap enzymes on the membrane surface. The hypothesis of the study was that, during the filtration of the alginate-enzyme solution, a particularly high local concentration of alginate will arise near the membrane surface (due to concentration phenomenon) and simultaneously, the cross-linking of sodium alginate will slowly occur in the presence of divalent cations (Ca^{2+}). As a result, the enzymes will be entrapped in the alginate layer. Compared to the traditional enzyme entrapment in alginate beads, the new strategy is intended to avoid enzyme leakage and overcome diffusion barrier by membrane sealing and flow-through operation. The study was performed in sequential manner: first, the most suitable types of alginate from different composition of mannuronate and guluronate residues which able to induce a very thin, sustainable gel layer by pressure-driven membrane filtration were selected and evaluated. Then, an efficient method to aid in the gel adhesion on membrane surface was developed by prior, polymerizing dopamine hydrochloride in alkaline buffer solution. After confirming that the enzymes loading could be remarkably enhanced, several strategies to increase the permeate flux were evaluated. The strategies

include the addition of polyethylene glycol (PEG) and control of Ca^{2+} concentration during gel layer formation step.



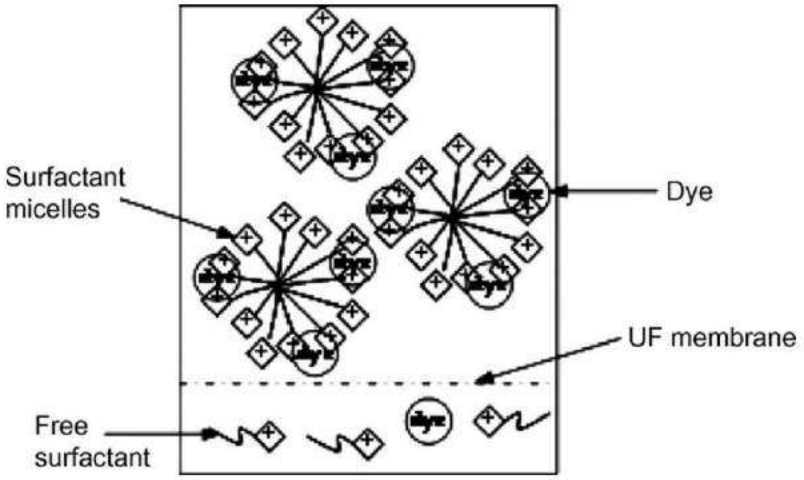
23.2.3 Impregnation of medicinal plant phytochemical compounds into silica and alginate aerogels

Herbal medicinal plants are important sources of bioactive, medicinal compounds. In this work, impregnation of phytol as a model compound and multicomponent Clinacanthus nutans (C.nutans) plant extracts into alginate and silica aerogels was investigated, applying two different methods: wet impregnation and supercritical impregnation. Two types of C.nutans extracts were prepared by microwave-assisted extraction (MAE) using either ethanol-water solvent mixtures or pure ethanol as solvent. The impregnated compounds were analyzed by Infrared spectroscopy (FTIR), thermogravimetric analysis (TGA) and chromatography (HPLC and UPLC-MS/MS). Results showed that supercritical impregnation method yielded the highest loading content with silica aerogels, with a content of 30.1 ± 0.6 wt% of the model compound phytol, and 11.5 ± 0.4 and 23.9 ± 1.0 wt% of the extracts obtained with ethanol/water and pure ethanol solvents, respectively. In the wet impregnation method, alginate aerogels exhibited higher loading than the silica aerogels regardless of their surface area properties, indicating that in this case other properties of carrier materials and the nature of compounds have a stronger influence on the compounds loading than the surface properties of the carrier. Impregnation in alginate aerogels yielded higher total phenols and flavonoids contents than in silica aerogels. Plasticized alginate biopolymer was formed when the supercritical impregnation was performed with excess of phytol at 200 bar and 40°C, indicating that the swelling and/or plasticizing effect of $SCCO_2$ was remarkable combined with the effect of excess solute.



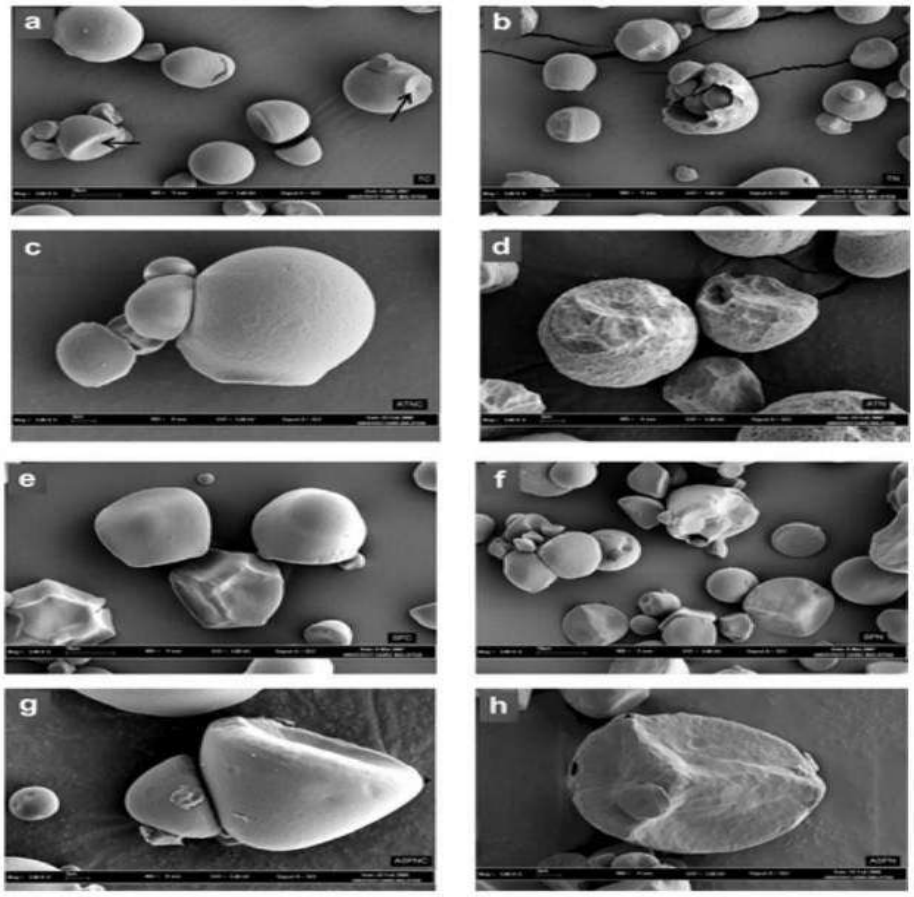
23.2.3 Reactive dyes decolourization from an aqueous solution by combined coagulation/micellar-enhanced ultrafiltration process

Micellar-enhanced ultrafiltration (MEUF) membrane process was applied to treat the reactive dye (C.I. Reactive Black 5 and C.I. Reactive Orange 16) in aqueous solution. In order to apply membrane separation technology, pre-treatment process was carried out to reduce high content of dyes in aqueous solution. Parameters including the effect of pH and coagulant dosages on dye removal have been studied and its optimum condition was identified. The optimum pre-treated solution will be further treated using micellar-enhanced ultrafiltration (MEUF). However, since the residual dye concentration of pre-treated solution for both dyes is not same, it is difficult to make comparison on the performance of dye rejection between these dyes. Here, a study on MEUF parameters was done on the same feed dye concentration of 0.050 g/L in order to identify the MEUF optimum condition. A cationic surfactant, cetylpyridinium chloride (CPC) was used in micellar-enhanced ultrafiltration (MEUF) process and its effectiveness was investigated. A thin film (TF) ultrafiltration membrane with 10,000 molecular weight cut-off (MWCO) was used under unstirred dead-end filtration. The effects of feed surfactant concentration and operating pressure on the permeate flux, dye and surfactant rejection have been studied and its optimum condition was identified.



23.2.4 Hydrolysis of native and annealed tapioca and sweet potato starches at sub-gelatinization temperature using a mixture of amylolytic enzyme

This study investigated the effect of annealing treatment (at 50°C for 72 h) on hydrolysis of tapioca and sweet potato starches using a raw starch hydrolyzing enzyme namely STARGEN001 (a blend from fungal α-amylase and glucoamylase) at sub-gelatinization temperature (35°C) for 24 h. The degree of hydrolysis of the starches was evaluated based on the dextrose equivalent (DE) value. The hydrolyzed starches were then characterized in terms of its morphology, swelling power and solubility, gelatinization and pasting properties, amylose content and x-ray diffraction pattern. After 24 h of hydrolysis, annealed starches were hydrolyzed to a greater degree with higher DE value compared to native starches (40% vs 33% for tapioca; and 29% vs 24% for sweet potato starch). Scanning electron microscopy (SEM) micrographs revealed a more porous granules and rougher surface in annealed starches than their native counterparts. The swelling power and solubility of annealed starches decreased significantly. Annealing was found to affect the pasting properties of the starches appreciably and increase the starch gelatinization temperature. The amylose content in hydrolyzed annealed tapioca and sweet potato starches increased while no significant changes observed in the X-ray diffraction of those starches. This study shows that the annealing treatment can be used as a way to increase the degree of hydrolysis of tapioca and sweet potato starches at sub-gelatinization temperature using a raw starch hydrolyzing enzyme.



23.3 Group Information and Background of Members

Name of RIG	Integrated Separation Technology Research Group (i-STRonG)
Leader	Dr Fauziah Marpani
Tier	5
RIG Code	CoRe175/T5/2018(24)/FMIA(30)
Registration Year (Senate Approval)	2018
UiTM Niche Area	Chemical & Advanced Materials
RIG Niche Area	Membrane separation and supercritical fluid extraction

Members	Details
	**Dr Fauziah Marpani (*P.Tech*), h-index 5, Faculty of Chemical Engineering** Biocatalysis, enzyme technology, membrane technology, reactive membrane filtration, particle technology, environmental impact assessment (EIA) Publication in: Journal of Membrane Science, ACS Applied Materials and Interfaces, Biotechnology and Bioengineering, Biochemical Engineering Journal
	**Assoc. Prof. Dr Zaibunnisa Abdul Haiyee, h-index 10, Faculty of Applied Science** Extraction and encapsulation technology Publication in: Food Chemistry, RSC Advances, Journal of Food Science and Technology. Molecules, Food Science and Technology
	**Dr Siti Wahidah Puasa, h-index 5, Faculty of Chemical Engineering** Membrane technology, industrial wastewater treatment, surfactant technology Publication in: Desalination, Chemical Engineering Journal
	**Dr Ana Najwa Mustapa, h-index 7, Faculty of Chemical Engineering** Supercritical fluid extraction, nanoparticles Publication in: The Journal of Supercritical Fluids, Industrial Crops and Products, Chemical Engineering and Processing: Process Intensification, Food Chemistry, Journal of Food Engineering, Industrial & Engineering Chemistry Research
	**Dr Putri Nadzrul Faizura Megat Khamaruddin, h-index 5, Faculty of Chemical Engineering** Wastewater treatment, advanced oxidation, adsorption, CO_2 management Publication in: Canadian Journal of Chemical Engineering, Hydrocarbon Processing
	**Nur Ain Mohd Zainuddin, h-index 2, Faculty of Chemical Engineering** Supercritical fluid extraction, industrial wastewater treatment Publication in: Conference proceedings

24.0

PERMANENT WAY INFRASTRUCTURE (PWI) RESEARCH GROUP

Mohd Ikmal Fazlan Rozli@Rosli, Juhaizad Ahmad, Azura Ahmad, Yee Hooi Min, Anas Ibrahim, Normariah Che Maideen, Kay Dora Abd. Ghani, Norliyati Md. Amin

24.1 Introduction

Permanent Way Infrastructure (PWI) research group is formed to focus on research related to behavior, deformation, damage and failure of railway infrastructure engineering materials when subjected to various types of loading and conditions.

Many activities emphasize on the following areas:

1. Analysis the behavior railway infrastructure properties based on experimental, mathematical modeling and simulation.
2. Development of new design, standard operating procedure of railway infrastructure structure.
3. Knowledge and technology transfer to government, local authorities and industrial agencies related to railway infrastructure information.

24.2 Research Highlights

24.2.1 Site Investigation with Keretapi Tanah Melayu Berhad (KTMB)

Permanent Way Infrastructure researcher from has been working together with engineering team from Keretapi Tanah Melayu Berhad (KTMB). PWI has been granted access to an active rail line and a problematic rail route to be investigated. Most of the sites were picked by KTMB because they know best of their rail system. This investigation were carried out to determine the behaviour of PCS in terms of deflection, strain behavior, soil behavior and soil-structure interaction of prestressed concrete sleeper. KTMB were kind enough to provide their personnel to accompany us during the time on site.

Figure 11.1 Site investigation

24.2.2 Finding the rhythm of the trains

Train is one of the most important and reliable means of transportation. Thus, a study on railway is indeed important for the development of railway engineering. In 1885, the first rail track has been completed and used in Malaysia (Tanah Melayu). The track is just 12.6 km long connecting Taiping and Port Weld in Perak. Since then the rail and train industry has evolved rapidly through time and the loading imposed to the rail structure is getting heavier and heavier. Generally there were four (4) dominant types of trains that currently been used in Malaysia and they are six coaches commuter train, three coaches commuter train, ETS train and freight train. This research was conducted to determine each types of train own unique rhythm and vibrations that imposed to the rail structure.

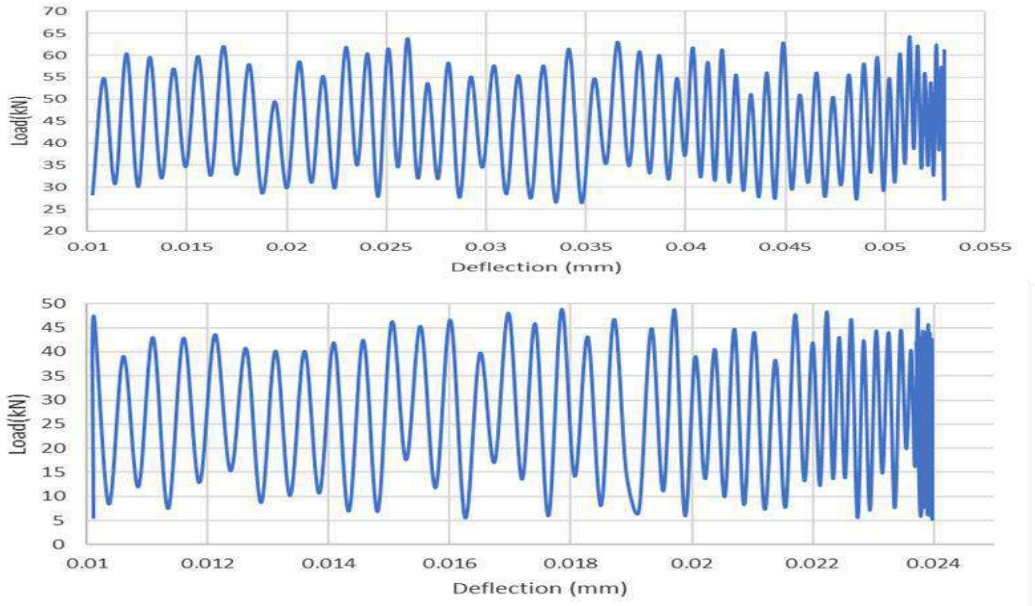


Figure 11.2 Various vibration behavior induced by different types of trains

24.2.3 Behaviour of Prestressed Concrete Sleeper (PCS)

PWI were also in the business of determining the behavior PCS in laboratory. The works can be divided into two (2) conditions that are static and dynamic condition. PWI would like to extend their gratitude to Eastern Pretech (M) Sdn. Bhd. for providing PCS samples from their batching plant for free. From that samples, the researcher can understand more about the PCS condition in laboratory conditions and also able to replicate almost exactly as on site condition in laboratory.

Figure 11.3 Laboratory test and a visit to Eastern Pretech (M) Sdn. Bhd.

24.3 Group Information and Background of Members

Name of RIG	Permanent Way Infrastructure (PWI)
Leader	Mohd Ikmal Fazlan Bin Rozli@Rosli
Tier	5
RIG Code	800-IRMI(CORE)(2/1/8)
Registration Year (Senate Approval)	2018
UiTM Niche Area	Railway Infrastructure
RIG Niche Area	Railway infrastructure Integrity & failure Analysis Research on integrity, failure and standard operating procedure of railway infrastructure components.

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Faculty of Civil Engineering
Expertise
Railway Engineering

Dr Kay Dora Abd Ghani
Faculty of Civil Engineering
Expertise
Earthquake Engineering

Dr Norliyati Md. Amin
Faculty of Civil Engineering
Expertise
Seismic Engineering

Assoc. Prof. Dr. Ir. Yee Hooi Min
Faculty of Civil Engineering
Expertise
Composite Engineering

Dr Hj Anas Ibrahim
Faculty of Civil Engineering
Expertise
Soil Engineering

Azura Ahmad
Faculty of Civil Engineering
Expertise
Substructure Engineering

Juhaizad Ahmad
Faculty of Civil Engineering
Expertise
Geotehcnical Engineering

Normariah Che Maideen
Faculty of Mechanical Engineering
Expertise
Advanced Manufacturing Technology

25.0

Researchers in FMIA

LIST OF FMIA DENOMINATORS YEAR 2019
COMMUNITY OF RESEARCH: FRONTIER MATERIALS & INDUSTRIAL APPLICATION (FMIA)

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