RESEARCH HIGHLIGHTS

ELECTROCHEMICAL MATERIALS AND SENSORS (EMaS) RESEARCH GROUP

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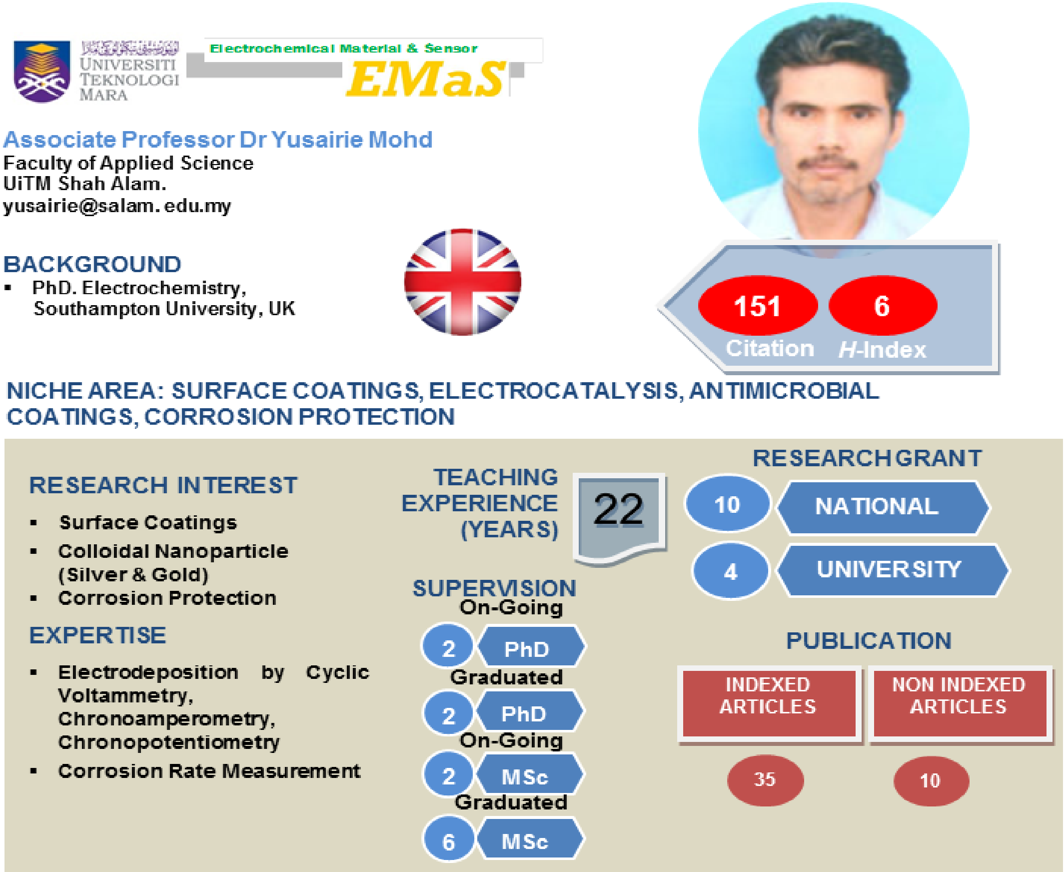
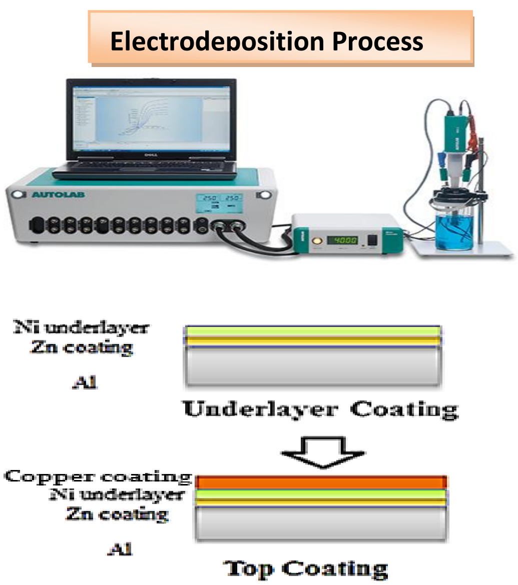
The nature of our research is highly interdisciplinary, emerging technologies from the fields of electrochemical sensors, microelectrode fabrication, electroanalytical chemistry, surface modification/coatings, electrocatalysis and material science (esp. nanoparticles characterization). Our research group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

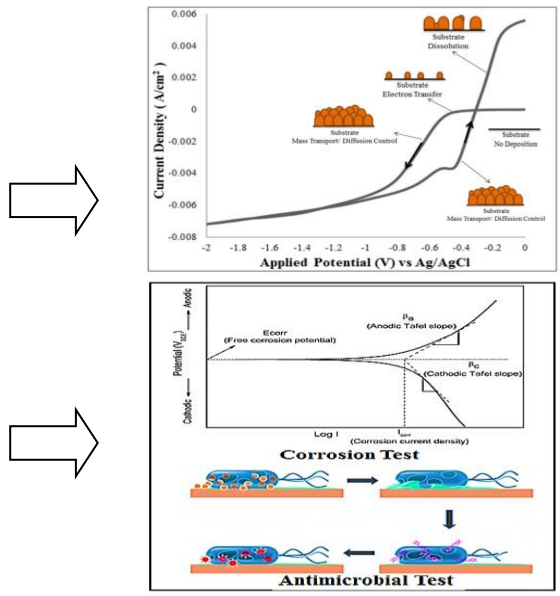
Ultimately, we plan to design, develop and manufacture novel devices for applications in a number fields including: biochemical sensing analysis,antimicrobial coatings, fuel cell and photovoltaic device development.

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.





2)Sensors

1. Trace determination of cadmium content in Malaysian herbs using graphene-ionic liquid-modified screen-printed carbon electrodes, Journal of Sensors and Sensor system,7,481-487,2018

2. Ruthenium Organometallic-bromophenol Blue Pairs in Hydrogel Sensing Matrix for Dissolved Ammonia FRET Sensor, : Sensors and Materials, Vol 30, 6 (2018) 1253-1261

3. An impedimetric micro-immunosensing assay to detect Alzheimer's disease biomarker: A40, Analytical Biochemistry,555 92018) 12-21

4. Copper Determination in Gunshot Residue by Cyclic Voltammetric and Inductive Coupled Plasma-Optical Emission Spectroscopy. MATEC Web of Conferences : EDP Sciences

5. Lipase Based Biosensors for Triglyceride Determination, MATEC Web of Conferences 59 Les Ulis: EDP Sciences

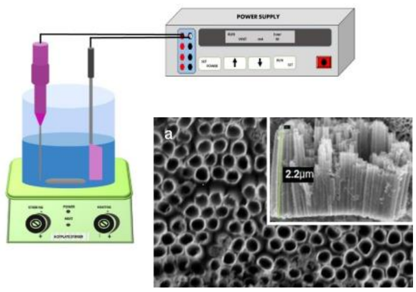
6. Detection of Breast Cancer 1 (BRCA1) Gene Using an Electrochemical DNA Biosensor Based on Immobilized ZnO Nanowires. Open Journal of Applied Biosensor, 3: 9-17

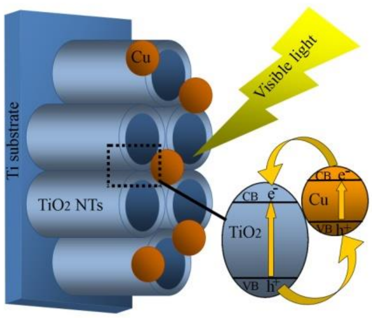
7. In vivo Electrochemical Biosensor for Brain Glutamate Detection: A Mini Review, Malaysian Journal of Medical Sciences, Special Issue, 12-26

3) Electrochemical Synthesis and Surface Modification of Photoanodes for Photoelectrochemical Solar Cell

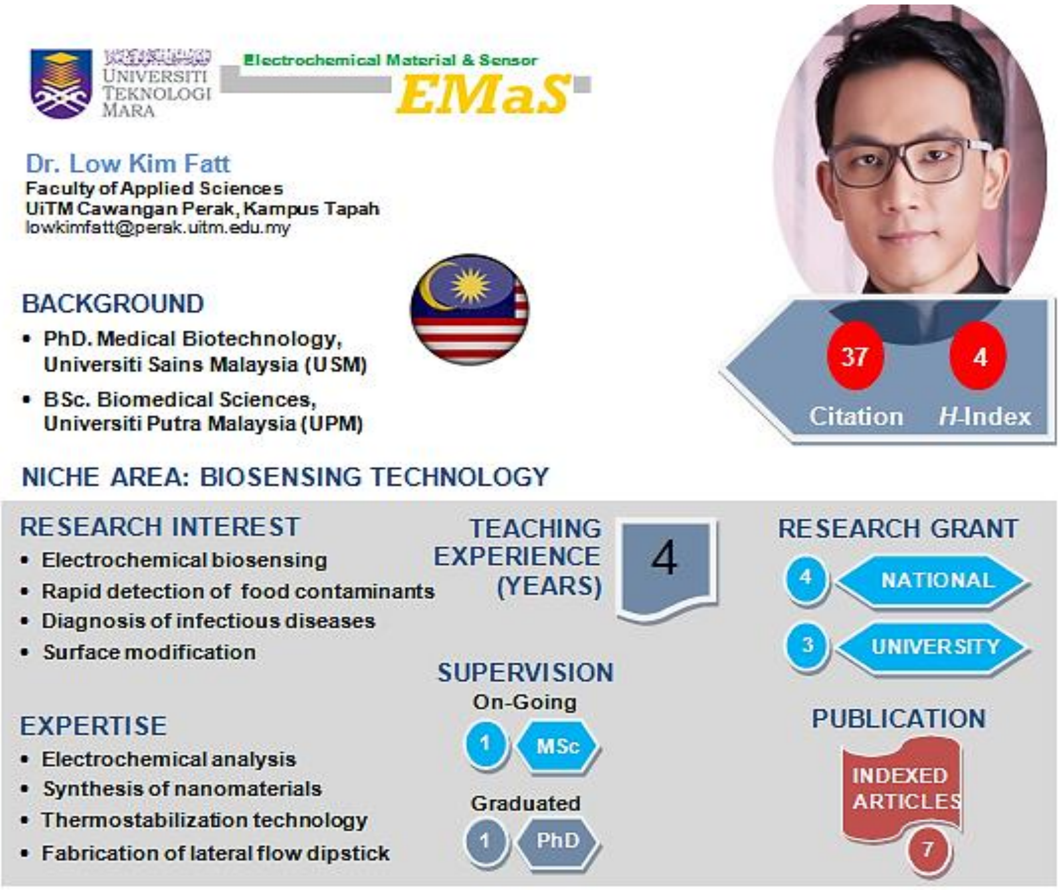
Electrochemical anodization can be defined as a controlled electrochemical growth of an oxide film on a metal substrate by polarizing the metal anodically in an electrochemical cell. Anodization can be conducted: (i) by potentiostatic mode (ii) by imposing constant current; galvanostatic mode, or (iii) 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

Electrochemical Anodization

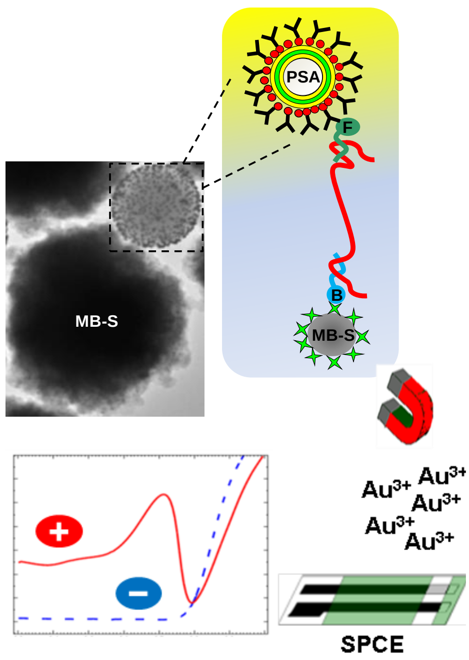




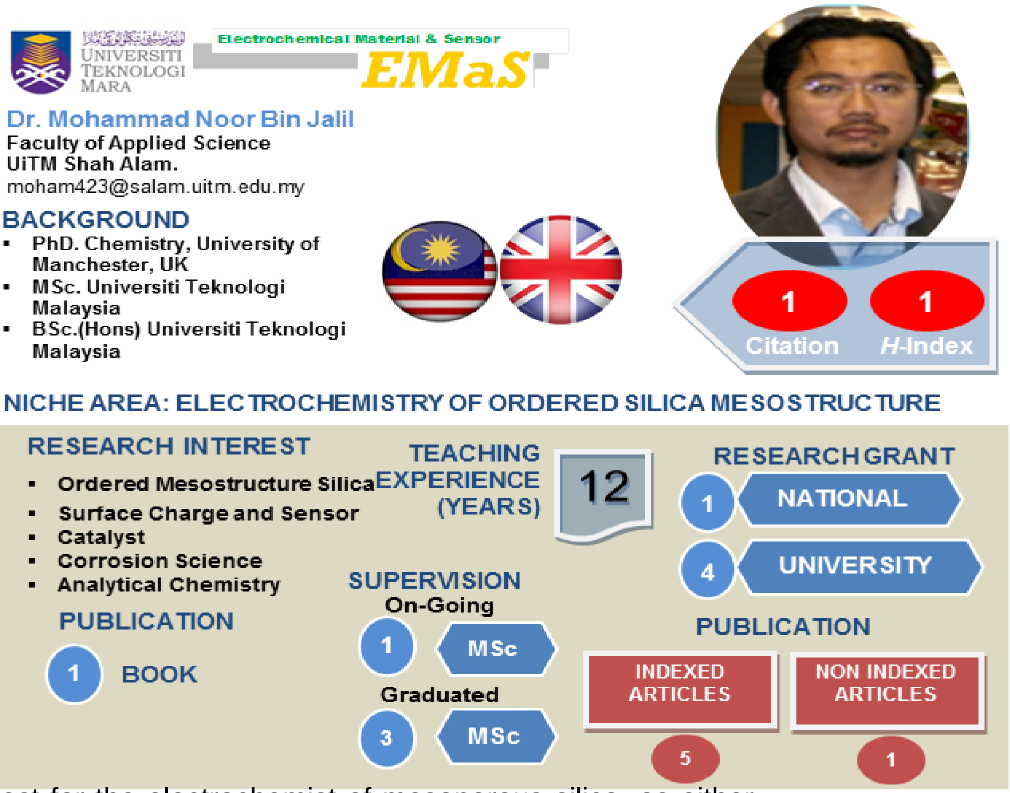
4) Design and Development of Novel Nanohybrid-based Electrochemical biosensors for food contaminants



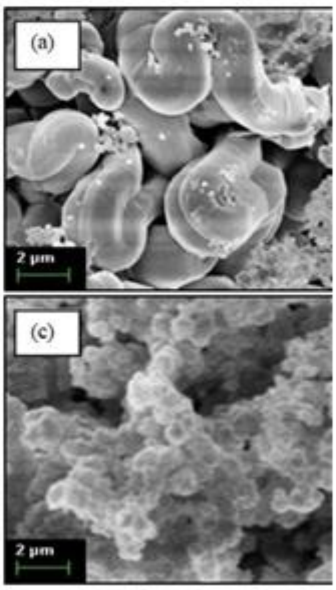
Electrochemical biosensors combine the analytical power of electrochemical techniques with the specificity of biorecognition processes. The basic principle of these biosensors is that the electroactive analyte species consumed and/or generated during a bio-interaction process is oxidized or reduced on the working electrode surface, which is subjected to some predefined pattern of fixed or varying potential, and the change in electrical parameters resulting from redox reaction, as a function of the type or concentration of analyte, is measured. With respect to other signal transduction techniques, electrochemical devices are highly sensitive, fast, accurate, easy-to-use, cost-effective, and amenable to miniaturization. These characteristics have made electrochemical technique the most suitable choice for the design of hand-held and portable sensing device. Based on a recent survey of literature, the electrochemical-based sensing assay is the most widely studied and in many cases the most often cited in the literature.

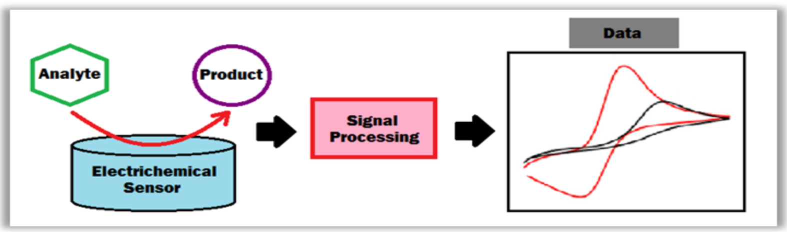


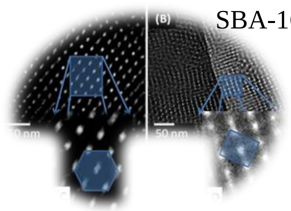
5) Electrochemistry of Order Silica Mesostructure



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.

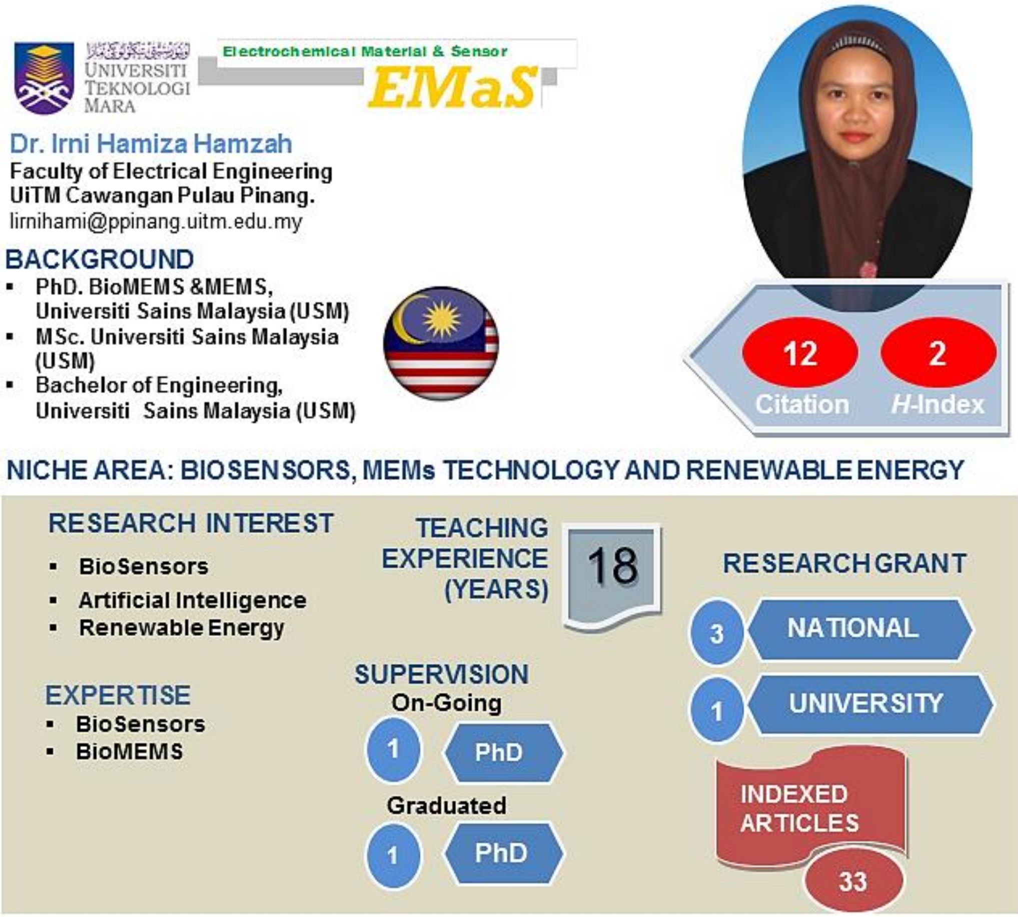






(TEM) images of the SBA-16 thin film

6) 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.