Project Leader: Dr. Yap Wing Fen

Project Title
Study on novel graphene quantum dots based thin films for potential detection of toxic chemicals using surface plasmon resonance technique

Executive Summary
Surface plasmon resonance (SPR) has been receiving continuously growing attention from scientific community for physical, chemical and biochemical sensing. This is mainly due to its high sensitivity to changes in the refractive index near the metal surface and label-free characteristics. However, when it comes to trace amount detection, especially for small molecular weight analytes, such as heavy metal ions, the recent angular interrogation SPR sensor has some bottlenecks especially in sensitivity and selectivity. Therefore a high affinity thin film on metal surface plays an important role. In this work we propose graphene quantum dots (GQD) based thin films to incorporate with SPR for sensing toxic chemicals include heavy metal ions and polycyclic aromatic hydrocarbon (PAH). The physical and optical properties of the novel thin films will be studied and characterized. The sensing ability of the novel thin films will be determined quantitatively and qualitatively using the metallic configuration based on angular interrogation SPR sensor. The incorporation of novel GQD based thin films with SPR technique is envisaged have a high performance to further improve the sensitive and selective detection of heavy metal ions and PAH.

Project Title
Optical investigation on detection of DENV II E-protein using surface plasmon resonance spectroscopy

Executive Summary
Nowadays, dengue, arthropod-borne viral diseases are dramatically grown in tropical and subtropical regions around the world. Infection from DENV will provide an immune response to patients by producing a slow and low titer immunoglobulin M (IgM), followed by immunoglobulin G (IgG), and immunoglobulin A (IgA) antibody that are mainly specific to the virus envelope (E) protein. To date, several conventional tests have been developed for identification of IgM and IgG antibodies to the DENV antigen. However, sufficient amount of antibodies is not detectable until the 5^{th} day of illness, and therefore is often not useful for early diagnosis of dengue. Hence, prompt and accurate detection of dengue virus is crucial in an early stage to prevent and minimize the spread of the harmful infections. With the advancement of today's technology, the rise of high sensitivity and selectivity of optical biosensor is replacing such conventional approaches. Surface plasmon resonance (SPR), one of the valuable optical sensor technique, has been receiving continuous growing attention from the scientific community for identification of antibodies to the dengue virus antigen. This is mainly to its high selectivity and sensitivity to specifically monitor the changes of refractive index in the vicinity of the immobilized surface ligands. In this research work, we propose the novel three-dimensional surface geometry layer, dendrimer modification above self-assembled monolayer (SAM) for the high sensitivity of protein detection system. In

order to determine the molecular absorption and activity of antibody-protein detection, careful assessments and evaluations on this material are carried out in relation to the physical and optical theory. In this case, by understanding the molecular interactions of antibody-proteins properties such as its selectivity and sensitivity, optical absorption and binding, and surface morphology, variations in the films thickness and analyte concentrations can be tailored to satisfy specific requirements. The success of this research work thus provides the basis of understanding for tailoring high selectivity and sensitivity of protein detection system.

Project Title

Synthesis, structural and optical studies of willemite based glass-ceramics derived from waste coconut shell as potential phosphor materials

Executive Summary

Solid residue from agricultural waste is produced in abundance globally and poses risk to health and environment if not treat carefully. Agricultural waste such as rice husk, sugar cane and coconut shell have the potential for production of renewable source of energy and raw materials such as silica (SiO_2). Thus, more research are being conducted on how to utilize these waste materials eco-friendly to its maximum potential. Extensive research are being conducted all over the world, especially on the optimum ways to extract the useful raw material in industrial application, SiO_2. Zinc silicate (Zn_2SiO_4) also known as willemite are heavily being research as this materials has been identified as a good host matrix for dopant of rare earth or transition metal ions due to their high quantum efficiency, super chemical and thermal stability, water resistance, and low cost in production. Willemite are being study because it have great potential especially in application such as photonic devices, next generation flat panel display (FPD), optical amplifier, and phosphors. The objective of this research is to extract SiO_2 from the agricultural waste sources (coconut shells) and to synthesize willemite from this source (coconut shell) as well to study their structural and optical properties. In this study, solid state reaction method are used to synthesize willemite as it is low cost method and are easy to be reproduce. The success of this research work will provide an alternative for these agricultural waste to be used to its maximum potential in more eco-friendly without polluting the environment and also provide the lower cost production of willemite in the future.