“Optimising synthesis and stability of Graphene Quantum Dots nanoparticles as new sensing material towards the development of rapid fibre optic biosensors for detecting pandemic viruses”

Mr. Muhammad Haziq Bin Noor Akashah
Dr. Siti Rabizah Makhsin
Ts. Dr. Rozina Abdul Rani
Faculty of Mechanical Engineering
Universiti Teknologi MARA, Selangor

Graphene quantum dots (GQDs) are known for their superior characteristics, especially for biosensing applications. This is due to their photoluminescence property, low toxicity and good biocompatibility. In this study, we have demonstrated the synthesis of GQDs via chemical reduction for fibre optic biosensor application. A simple method to synthesise GQDs using GO as the precursor. GO was prior synthesised using modified Hummers Method from raw graphite flakes. Different behaviour of GQDs was studied yet all of the synthesised GQDs possess highly luminescent blue emission (461-465 nm) under ultraviolet irradiation conditions (325 nm) were obtained its final product in 5 hours. Although the initial produced GQDs in the acidic solution state was not the suitable pH configuration for the purpose of the coating due to the highly acidic state, hence further neutralisation was conducted by removing the acid medium via evaporation and dispersed the remaining dried GQDs in ultra-pure water. The final pH was found at 4. The products were then characterised using UV-Vis, fluorescence spectroscopy, Fourier-transform infrared spectroscopy (FTIR) and x-ray diffraction (XRD) spectroscopy and transmission electron microscope (TEM). The quantum yield of the synthesised GQDs was obtained as high as 48%. The GQDs were found to maintain stability against photobleaching when stored in a confined space over a period of up to 90 days. The synthesised GQDs were coated onto fibre optic core after surface modification using chromic acid to introduce extra silanol site on the core surface and was found to be sensitive in detecting different refractive index (RI) of glycerol (1%,3%,5% and 10%). The relationship between the signal (peak intensity) and RI of glycerol solutions (ngly) with linearity; R^2 of 0.7589. Hence, the designed sensor showed outstanding performance in detecting different RI with sensitivity of 14598 ± 0.015 RIU^{-1}. The result obtained showed that this proposed method in the synthesis of blue-emitting GQDs can be utilised further in biotechnology applications such as biosensor and bioengineering; for example, in the immobilisation of cancer markers on the surface of GQDs.

Funded by Toray Science Foundation, Japan