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Research Proposal

Title	Development of graphene/metal nanoparticle based nanocomposite catalysts for fuel cell and photocatalytic applications
Keywords	Graphene, metal nanoclusters, supercapacitor
Abstract	Graphene based materials has attracted increasing research interest in both scientific studies and technological development. Many unique physical and chemical properties of graphene have been discovered, and it is a promising candidate material for many applications, such as batteries, supercapacitors, fuel cells, photovoltaic devices, and biosensors. Fuel cells are one kind of electrical energy conversion device which transform chemical fuels (methanol, ethanol or formic acid) to electrical power by oxidizing fuels (anode) and reducing oxygen from air (cathode) in the presence of catalysts. One of the key challenges for fuel cells is to develop highly active and low-cost catalysts. Recently, graphene-based noble metal nanostructures are used as electrocatalysts and these materials have demonstrated good performance in fuel cells due to the large specific surface area and good electrical conductivity of graphene and excellent catalytic activities of noble metals. The efficiency of fuel cells is dependent on electrocatalysts, which can improve the activity of the oxygen reduction reaction (ORR). Hence, it is important to develop new electrocatalysts which will play a fundamental role in fuel cell systems. Metal (precious or non-precious) nanoparticles can improve the high activity of ORR. In particular, the combination of noble metals and carbonaceous materials (such as carbon nanotubes (CNTs), graphene oxide and reduced graphene oxide, nanosheets of graphene) can significantly enhance their catalytic, electrochemical and electrical properties of the nanocomposites. Further surface enhanced Raman scattering (SERS) is a powerful and reliable analytical technique for detection of analytes with high sensitivity and selectivity. It has been established that graphene has a strong Raman enhancing effect *via* the chemical mechanism (CM). This mechanism, based on charge transfer, originates from the unique single-layer 2D structure of graphene, making it an excellent candidate for the SERS substrate. It should be noted that plasmonic nanoparticles (especially Ag and Au) with rough surfaces are valuable materials for SERS. Importantly, the combination of noble metal NPs with GO or rGO gives rise to further improved SERS performance. From the above information, it is proposed to synthesis graphene/metal nanoparticle based nanocomposites and studies their catalytic properties in the applications of fuel cell and photocatalytic degradation of dyes in polluted water.
Project Description	Ag or Au nanoparticles will be synthesized via ion exchange method or solgel method. Graphene oxide or reduced graphne oxide (rGO) will be synthesized *via* green methods and the nanocomposite will be prepared by mixing the nanoparticles with GO in appropriate concentration. These samples will be characterized with different experiments to find phase purity and the nature of chemistry. These samples will be studied *via* C-V measurements to find the suitability for

	supercapacitor applications. Further, the photocatalytic effects will be demonstrated with dye sensing agent.

Proposal:

Soda-lime glasses doped with silver ions by the ion exchange technique were initially employed in the production of active or passive waveguide systems. Doping these glasses with embedded silver nanoparticles broadens their potential applications, as shown by the experimental demonstrations of all-optical switching or molecular detection through Surface Enhanced Raman Scattering (SERS). It is planned to carryout grapheme/reduced graphne oxide on Ag nanoclusters containing soda lime glass will be prepared and it will be used for possible applications in photocatalysis or supercapacitors.

Clues – Synthesis of metal clusters on Sodalime glass and tip it with grapheme (synthesis by some green methods)

Looking for electrical resistance change upon visible light ON/Off conditions. Also one can plan to do photocatalysis with Rhodamine B. The characterization side, you can do, XRD, SEM and Raman and UV-Vis spectroscopy and I-V and C-V measurements.