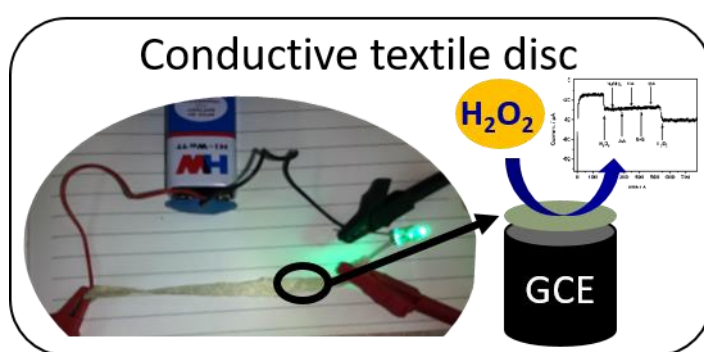


Significant Contribution – Dr. M. Anbu Kulandainathan

1. Smart Fabrics – Medical/ Fire retardant/Self Cleaning/UV Protection, 12th FYP Project (CSC 0134)

a) Highly Conductive Nano-Silver Textile for Sensing Hydrogen Peroxide

A promising field of research is developing on flexible conducting textiles. There are many multifunctional applications, such as in wearable electronics, health monitoring, military, or as electrode surfaces in energy conversion and storage systems (supercapacitors, battery and fuel cells). Silver nanoparticle embedded-viscose fabrics produced by an electroless coating method have been demonstrated to give a resistance of $0.26 \Omega \text{ cm}^{-1}$. A glassy carbon electrode with nano-Ag textile disc attached (GCE-Ag NPs) exhibits a selective electro catalytic response towards H_2O_2 even in the presence of interferences like ascorbic acid, uric acid, nitrate, dopamine, and glucose. The modified electrode has shown a sensitivity of $35.97 \mu\text{A}/\text{mM}$ for hydrogen peroxide, with a detection limit of $13 \mu\text{M}$ across a wide linear range of $20 \mu\text{M}$ to 33 mM H_2O_2 . The effects of the fabric morphological changes after sensing of peroxide was further investigated using scanning electron microscopy (SEM), x-ray diffraction (XRD) and water contact angle studies.

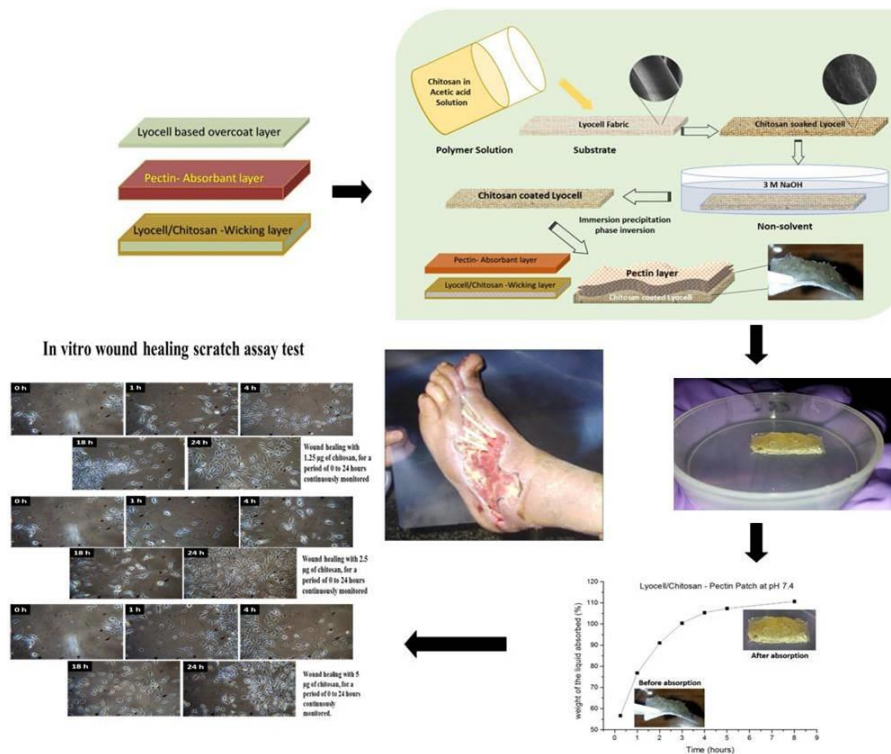


Paper has been communicated to J. Electroanalytical Chemistry, 2017

b) Diabetic Wound Healing Dressing

Diabetic Foot Ulcer (DFU) is one of the complications of Diabetes mellitus, which, if left untreated can lead to amputation or even death. If proper wound care is administered in the initial stages of the wound, further complications can be avoided. Hence, we have developed a wound healing dressing using biopolymers.

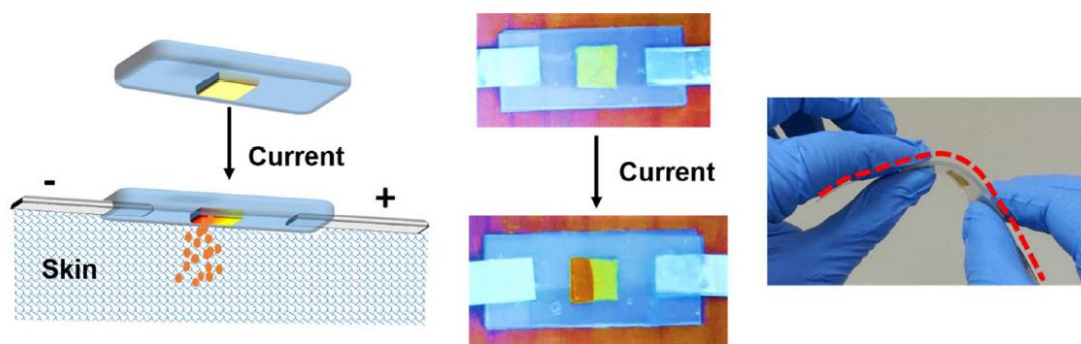
Chitosan(as active material) coated Lyocell, is the wicking layer which will be in direct contact with the wound and Pectin acts as a absorbant layer (DFUs are highly exuding wounds). All three biopolymers are biocompatible and biodegradable. Scratch assay test conducted on L929 Mouse fibroblast cells have shown that, the thus prepared dressing shows positive healing response. Animal trials for further validation are underway.



2. Silica/Alumina encapsulated fluoropolymers as a Core-Shell Nanostructure for Superhydrophobic Fabrics, DST Project, Rs. 26.50 Lakhs (GAP 08/13)

a) Textile Drug Delivery: Electrochemically Driven Solubilisation and Controlled Release for Wound and Anti-Cancer Applications

Existing drug delivery methods are commonly based on stabilising or solubilising agents which may affect the efficacy of drug therapy. Here, we have successfully demonstrated a novel in-situ solubilisation and drug delivery method based on an electrochemically driven process that produces a soluble form of the drug to be delivered through skin or into a wound. The driving aluminium electrodes are integrated into the textile to locally create basic conditions that solubilise and deliver the curcumin drug to skin or wound. Natural curcumin is investigated here as a model case for applications including anticancer (tested for HeLa cell lines) and anti-bacterial (tested for *S. aureus* and *K. pneumonia*). This new methodology can deliver drug with electrochemical stimulation or precisely controlled rate of release over a longer period of time. Excellent results were obtained with a simple low-cost device concept.

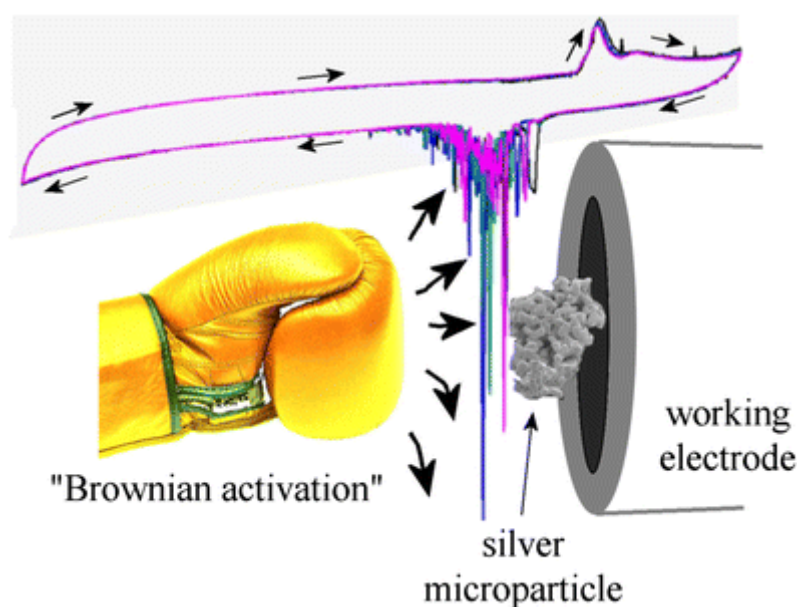


A Patent has been filed.

3) Metal-Organic Redox Frameworks (MOFs) for Photochemical Textile Processes (UGC-UKEIRI Project)

a) Redox reactivity at silver microparticle—glassy carbon contacts under a coating of polymer of intrinsic microporosity (PIM)

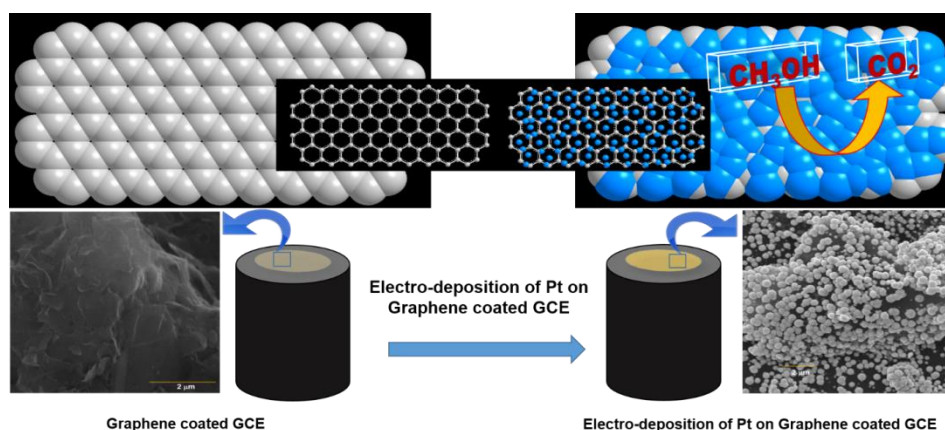
Silver microparticles (ca. 1 μm average size clustered into cage-like aggregates of 10–20 μm diameter) are shown to adhere to a glassy carbon electrode surface to give voltammetric current responses, which are considerably enhanced/stabilised when applying a coating with a molecularly rigid polymer of intrinsic microporosity (PIM-EA-TB). In preliminary voltammetric experiments characteristic Ag(0/I) surface oxidation and back-reduction processes are observed in aqueous phosphate buffer (associated with silver phosphate layer formation on the silver surface). In contrast to the oxidation, which is dominated by a nucleation process causing a sharp well-defined current signal, for the back-reduction stochastic current responses are observed possibly associated with density fluctuations in the surrounding liquid phase (“Brownian activation”) as an essential part of the mechanism of conversion of surface-oxidised silver back to silver metal.



Other Research Works:

a) Highly efficient, large surface area and spherically shaped Pt particles deposited electrolytically synthesized graphene for methanol oxidation with impedance spectroscopy

Graphene was synthesized via electrochemical exfoliation technique of graphite rod in Poly (sodium 4-styrene sulfonate) solution. Laser Raman and X-ray Diffraction Spectroscopies were used to confirm the defects and crystal nature of graphene. The surface wettability studies based on water contact angle, further differentiates the affinity of as-prepared graphene and pristine graphite towards water. Modified Glassy carbon (GC) electrodes were prepared by electro-deposition of Platinum (Pt) on bare and graphene coated GC, denoted as GC/Pt and graphene/Pt modified GC respectively. The morphology and chemical composition of the thus synthesized graphene and graphene/Pt modified electrodes were investigated by High resolution transmission electron microscopy, Scanning electron microscopy and Energy dispersive spectroscopy. The electrochemically active surface area of the electro-deposited spherically shaped Pt particles was calculated to be $63.96 \text{ m}^2\text{g}^{-1}$ and $25.10 \text{ m}^2\text{g}^{-1}$ on graphene/Pt and GC/Pt, respectively. The electro-catalytic performance of modified electrodes for methanol oxidation was envisaged by cyclic voltammetry, linear sweep voltammetry and chronoamperometry. Graphene/Pt modified GC electrode showed higher oxidation peak current (42.90 mA cm^{-2}) than GC/Pt modified electrode (16.24 mA cm^{-2}) in forward scan of methanol oxidation because of the uniform distribution of spherically shaped Pt particles on graphene. The reaction path for methanol oxidation at different potentials was elucidated by means of Electrochemical Impedance Spectroscopy.

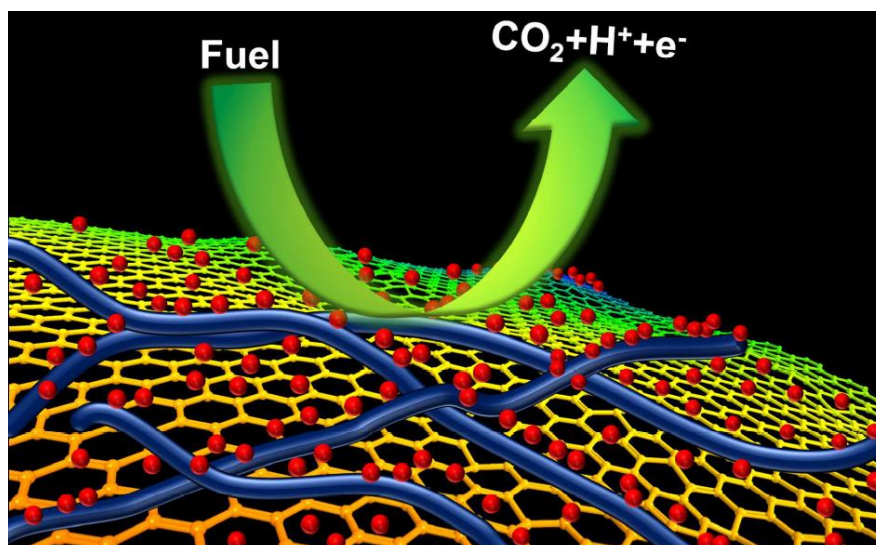


A Paper has been published in International Journal of Hydrogen Energy, 2017

b) One-pot synthesis of highly efficient graphene based threedimensional hybrid as catalyst supporting material for electro-oxidation of liquid fuels.

The electrocatalytic oxidative performance of fuels like methanol, ethylene glycol, formaldehyde and formic acid mainly depends on the electrode surface which in turn has application in energy generating systems like fuel cells. The surfaces should have selectivity, stability and low onset potentials (high kinetics for the electro-oxidation). We synthesized high quality few-layered Graphene by simple and fast electrochemical exfoliation of graphite rod using poly (3, 4-ethylenedioxy thiophene)-poly (styrenesulfonate) (PEDOT: PSS) as an effective electrolyte, which was further used for the synthesis of Graphene-MWCNT hybrid. Pt decorated composites were synthesized by reduction with sodium borohydride. These composites were characterized using Xray diffraction spectroscopy, Raman spectroscopy, FT-IR spectroscopy, UV- Visible absorption spectroscopy, X-ray photoelectron spectroscopy, Field-emission scanning electron microscopy and High-resolution transmission electron microscopy. The electrochemical active surface area of the Graphene-MWCNT/Pt, MWCNT/Pt and Graphene/Pt modified catalysts were calculated to be 88.76, 38.41 and 14.6 m² g⁻¹ , respectively. The performance of Pt decorated modified electrode catalysts towards the oxidation of liquid fuels were studied using cyclic voltammetry, linear sweep

Journal of Materials Chemistry A voltammetry and chronoamperometry in acidic media. The oxidation efficiency of liquid fuels on Graphene-MWCNT/Pt also explained and it follows the order: formaldehyde > methanol > ethylene glycol > formic acid, in the decreasing order of oxidation efficiency.



A Paper has been published in J. Materials Chemistry, 2017