# The University of Queensland - IIT Delhi Academy of Research Joint PhD Project

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| **PROJECT TITLE** | **ELECTROSPUN TEXTILE MATERIALS MODIFIED WITH METAL OXIDE NANOPARTICLES FOR ELECTROCHEMICAL CAPACITOR APPLICATIONS** |
| **PROJECT CODE** | **UQIDAR 00172** |
| **PROJECT DESCRIPTION** | Harvesting renewable energy is unarguably one of the great challenges of this century to meet the increasing energy demand and minimizing environmental footprint. Flexible supercapacitors are potential devices for energy storage as they are not restricted by bulk designs and configuration as compared with the traditional ones owing to their lightweight, small size, high efficiency and greater stability. The flexible energy storage devices should be comprising of highly efficient, non-flammable, shape conformable, inexpensive, non-toxic, and scalable materials. However, most of the conventional devices developed/reported so far are not up to the standard. The different carbon sources like graphene, CNTs, nano metal oxides, and conducting polymers were used as electrode materials. Nevertheless, the deficiency of high-performance, reliable and shape-conformable materials the development of or commercialization of flexible electrodes and their structural designs are still most attractive field in energy storage application. Motivated with this, the main research domain of the proposal is focused on synthesis of flexible 1D energy material by electrospinning method. 1D nanofibers with straight pores for improved intercalation and de-intercalation with electrolyte is the most convenient structures for in-situ incorporation of carbon and assembly with carbon-based materials (activated carbon, graphene, carbon nanotubes, or their composites, etc.) for high conductivity and high specific surface area for double-layer charging. Electrospinning is one the most cost effective, greener synthesis method and environmental pollution with relatively high production rate, which is helpful for generating porous structured 1D flexible material with their improved conductivity, high surface area, large surface to volume ratio and porosity. In this regards the redox-active transition metal (Mn, Fe, Co, V, Sn, Ni etc.) based oxides/sulfides, or polymers (polyphenylenes and their derivatives) composite MOs are most promising electrode material having high theoretical capacity, low cost, natural abundance, non-toxic, good environmental compatibility, large surface area and high conductivity. |
| **PROJECT OUTCOMES** | • Processing of new polymer derived nanofibers as electrochemical cells for energy storage.<br>• To develop new supercapacitor technology with low cost and wide domain applicability.<br>• To develop a facile, low-cost textile electrode which has great potential in the field of flexible energy storage devices.<br>• To publish research data in form of papers/patents, theses, and presentations. |
| **ADVISORY TEAM** | **Professor George Zhao**<br>https://www.chemeng.uq.edu.au/clean-energy-and-water-research-contact<br>george.zhao@uq.edu.au<br>School of Chemical Engineering<br>The University of Queensland<br><br>**Associate Professor Pravin Ingole**<br>https://sites.google.com/site/drpraviningole/home<br>ppingole@chemistry.iitd.ac.in<br>Department of Chemistry<br>Indian Institute of Technology Delhi |

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| **TYPE OF STUDENT** | Applications are open to i/a students who meet eligibility criteria.<br>note: i-students must have own scholarship to apply (CSIR, UCG-NET, etc) |
| **DISCIPLINE BACKGROUND OF STUDENT** | Ideally, this project requires students with a background in physical chemistry, physics, materials science and engineering, chemical engineering. |
| **IDEAL CANDIDATE** | Essential capabilities:<br>• being trained in a research project or program with research experience,<br>• capability of design and implement of experiments,<br>• capability of writing scientific papers without significant logic problems,<br>• capability of communicating research data concisely,<br>• willing to work hard,<br>• willing to help other people if needed,<br>• able to communicate with supervisors frequently and effectively.<br><br>Desirable capabilities:<br>• good skills in interacting with people, able to use instrumental analysis techniques for characterisaing solid materials such as SEM/TEM, XRD, XPS, physisorption, GCD, CV and EIS.<br><br>Expected qualifications (courses, degrees, etc):<br>• Master's degree |
| **APPLICATION PROCESS** | Apply online by the due date: https://www.uqidar.org/students/how-to-apply/ |