AY2019-20
UROP PROJECTS

School of Materials Science & Engineering

PROJECT OFFERED BY
ASSOC PROF. NRIPAN MATHEWS

Development of new polymer composites for field-driven soft actuators (Dielectric elastomer actuators)

Project Objectives:

- Research Outcomes:
- Synthesis and characterization of polymer composites with novel conducting, semi-conducting and ionic fillers.
- Comparison among the synthesized composites for the electrical and mechanical properties.
- Learning Outcomes:
- Student would be able to understand the steps in the chemical synthesis process and perform the synthesis on their own as well.
- Student would be able to understand the working principle of characterization techniques like capacitance measurement, uniaxial tensile testing, differential scanning calorimetry and thermogravimetric analysis and perform the measurements independently.

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Project Description:

- Soft robotics is an emerging research area, which draws inspiration from nature and are made of soft materials like elastomers. There are different strategies like pneumatics, fluidics, magnetic fields, thermal perturbation and electric fields that researchers have adopted for producing actuation. Out of these, electroactive polymers, that respond to electrical stimuli, are attractive. Within the family of electroactive polymers, dielectric elastomer actuators are of particular interest owing to their ability to produce large actuation strains, facile fabrication and fast response times. The performance of these dielectric elastomer actuators depends on the intrinsic material properties like dielectric constant and mechanical stiffness.
- The project is going to focus on the fabrication of novel polymer composites with an aim to modify these material properties. Where addition of ceramic fillers like TiO_2 to polymers have been done in the past, the project focusses on using novel conductive, semi-conductive and ionic fillers. Judicious choice of the fillers could lead to desirable changes in the electrical and mechanical properties of the polymer. Under the project, the student is initially expected to familiarise themselves with the state of the art by doing a thorough literature review. Next, they are expected to focus on synthesis of the polymer composites (via different routes). Finally. The students have to perform the characterizations and analyse the data.
- Key words: soft robotics, electroactive polymers, dielectric elastomer actuators, polymer composites.

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Major Tasks:

- 1. To conduct literature review and critically analyse the existing strategies.
- 2. To master the synthesis steps for certain samples.
- 3. To understand certain principles relevant to the project.
- 4. To get trained for certain material characterization techniques.
- 5. To work as a team member with other members of the research lab.
- 6. To analyse obtained data and draw meaningful conclusions.

PROJECT OFFERED BY
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Printed metal oxide thin film transistors for flexible electronics

Project Objectives:

- Fabrication of low temperature processed printed n-type and p-type metal oxide TFTs on flexible substrates.

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Printed metal oxide thin film transistors for flexible electronics

Project Description:

- Amorphous metal oxide semiconductors (AMOS) have emerged as the material of choice for flexible electronics by virtue of their large area uniformity, high electron mobility, low fabrication cost and solution processability. However, solution processed metal oxide semiconductors are plagued by the need for high temperature anneals necessary for the formation of high quality TFT worthy semiconducting films. This project aims to fabricate printed, low temperature metal oxide TFTs by utilizing various techniques such as precursor/additive selection, photochemical annealing, conductive fillers etc. These techniques will be comprehensively investigated, analyzed and later adopted to fabricate high performance flexible AMOS TFTs.
- There is a dearth of studies on P-type AMOS TFTs as it is challenging to achieve high performance due to their inherent electronic structure. However, an efficient, robust p-type AMOS is imperative to achieve a CMOS system. To address this issue, the project will also explore various promising material systems for the development of p-type semiconducting channel for TFT applications.
- Key words: AMOS, flexible electronics, inkjet/screen printing

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Printed metal oxide thin film transistors for flexible electronics

Major Tasks:

- To understand the chemical and material properties of AMOS systems used for TFT applications and existing challenges
- To learn the synthesis of precursor solutions and optimizations necessary for improving the printability of the precursor solutions
- To learn the complete fabrication process of an AMOS TFT
- To conduct material and electrical characterizations of fabricated TFTs
- To analyse the results and optimize the material system based on these investigations