Title: Nonoscale CMOS Devices and Nanowire Device Characterization

PI: Durga Misra

Abstract: This project characterizes Nanoscale CMOS devices and Semiconductor nanostructures. Electrical characterization includes NBTI, PBTI, SILC, TZDB, TDDB, interface states and low temperature characterization. Defect Characterization of Thin-film (CdTe) and Silicon Solar Cells are also carried out. Nanowire InGaN/AlGaN light emitting diodes are also characterized.

Current Funding: TEL Technology Center, America, LLC
Title: NEW NON-PGM CATALYSTS FOR ELECTROCHEMICAL SYSTEMS

PI: Dr. Eon Soo Lee, Mechanical & Industrial Eng

Abstract: The goal of this research is to use non-precious metal materials such as carbon, nitrogen, transition metal, and porous material to synthesize a new non-precious metal (non-PGM) catalyst for electrochemical systems and industrial catalysis.
Title: Enhanced Riverbank Filtration with In-Situ Air Nano-bubbles Treatment

PI: Taha F. Marhaba & Ahmed K. Ahmed (PhD candidate)
John A. Reif, Jr. Department of Civil and Environmental Engineering, New Jersey Institute of Technology

Abstract: Surface water bodies are exposed to pollution as a result of discharging untreated liquid wastes from industrial, agricultural and domestic activities. Riverbank filtration (RBF) offers a cost-effective in-situ technique for producing treated water by removing suspended solids, pathogens, trace organics, bacteria, viruses, inorganic compounds and micro-pollutants. A novel method is being investigated in this research, which enhances the effectiveness of the RBF as a water treatment process. The in-situ process involves the injection of air Nano-bubbles injection during RBF. Laboratory pilots will be used to evaluate the process. Parameters evaluated include dissolved oxygen, hydraulic conductivity, UV254, SUVA, dissolved organic carbon, and some heavy metals (lead, Cadmium, Iron, Magnesium, Mercury).

Labs/Instruments:
- York Center:
  - TOC Analyzer – combustion
  - ICPMS
  - Flame Atomic Absorption Spectrometer (Flame AA)
- Water lab in Colton Hall:
  - Air Nano-bubbles generator
  - Turbidity meter
  - Dissolved Oxygen Meter

[Diagram of RBF system and injection process]
Title: Chemical and Structural Characterization of Colloidal Nanocomposite Thin Films

PI: Dong-Kyun Ko

Abstract: The overall goal of the project is to create a nanocomposite co-assembled from two different kinds of semiconductor nanocrystals with targeted nearest-neighbor arrangement. This new class of performance-tailored nanomaterial will be used in advanced thermoelectric applications.

Harvesting body heat to generate electricity
Title: Decontamination of Passaic River sediments using Ultrasound and Ozone nano bubbles

PI: Jay N. Meegoda, Janitha H Batagoda

Abstract: The industrialization has brought in so many manmade compounds in larger concentrations into the Passaic river basin making it the second heavily polluted river in the United States. The objective of this study is to develop an in-situ remediation method using ozone nano-bubbles and ultrasound to treat the contaminated sediments. A set of laboratory scale experiments will be carried out using simulated dredged sediments from the Passaic River to identify the impact of sonication time, sonication power, pH in water ozone concentration and temperature on oxidizing PAHs. Once the baselines are established, the feasibility to use the proposed method for heavy metals and other organic contaminants will be examined. The data extracted from the laboratory experiments will be used to develop a field application of the technology. The observations from the pilot tests will be used to optimize the field application.
Title: Gate Electrodes within Electrochemical Cells

PI: H. Grebel

Abstract: In order to control the ion flow in electrochemical cells we place gate electrodes between the anode and the cathode of the cell. By applying a bias potential to this gate electrode, we are able to control the external current of the cell. This construction would be the first step towards the realization of ion transistors. In preliminary studies, several gate electrodes were considered: layers of functionalized carbon nanotubes (CNT) and metal plate capacitor. Cyclic voltammetry (CV) and Electrochemical Impedance Spectroscopy (EIS) revealed the effect of the gate bias on the effective capacitance and impedance of the cell. The proposed research project is aimed at understanding the mechanisms involved in this gate construction. Surface morphology of the gate membranes will be analyzed using scanning electron microscope (SEM) EDX and XRD. Raman spectroscopy will be used to assess the carbon nanotube gate membrane. Finally, we will use AFM to assess the gate electrode thickness construction.

Left: The structure. Blue - electrons; Red - ions. Right: Raman spectra of the structure. A small relative shift is noted for the various peaks.
Sustainable Nanotechnology for Energy & Environment Laboratory

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Major research areas:
• Visible-light-Driven Photocatalytic Processes to Produce H₂ and Remove Water Pollutants
• Antibacterial Applications (e.g., water disinfection) and Toxicity Assessment of Engineered Nanomaterials
• Biofuel-production and nutrient Recovery from Wastewater
• Reactive Ceramic/Polymer Membrane Development

Major funding sources:
NSF, DOE, USDA, and NSF Membrane Science Engineering and Techno (MAST) Center.

Zhang, Wen, etc, ACS applied materials & interfaces 2015, Environmental Science & Technology 2014; Bioresource technology 2014, 166, 266-272.
Title: ECTFE Membrane Characterization after Exposure to Different Operating Conditions

- Study various properties and changes in ECTFE membranes subjected to solvent sorption, radiation exposure and pH variation*

1. X-ray diffraction analysis
2. Scanning electron microscopy
3. Thermogravimetric analysis
4. Raman spectroscopy**


**Na Yao, Boris Khusid, Kamalesh K. Sirkar, and Derek J. Dehn, Manuscript submitted for publication, 2017.
Title: High Efficiency Deep Ultraviolet III-Nitride Nanowire Light-Emitters

Abstract: A compact, highly efficient, and high power ultraviolet (UV) light-source with emission wavelengths below 350 nm has attracted great attention due to its wide range of applications. The primary applications of such UV emitters include remote detection of biological and chemical compound, cancer detection and fluorescence sensing or Raman spectroscopy. Moreover, UV LEDs and laser diodes (LDs) offer great potential applications in data storage, high-speed communications, information processing, optical interconnects. The main objective of this research program is to investigate the molecular beam epitaxial growth and fabrication of III-nitride LEDs on Si and patterned substrates operating in the ultraviolet (UV) wavelength region (from 210nm to 350nm).

Rajan Philip et al., Journal of Advanced Optics and Photonics, 1 (2018) 3
Djavid et al., Photonics and Nanostructures - Fundamentals and Applications, 28 (2018) 106