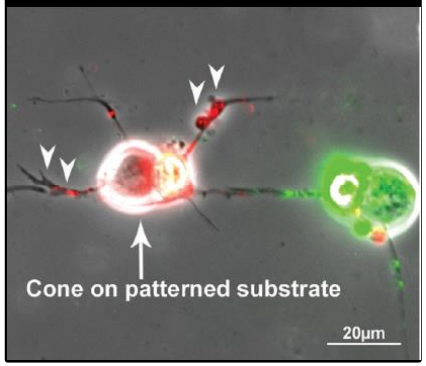
Multi Disciplinary Laboratories at the Otto York Center

NJIT
New Jersey Institute of Technology

Bio-Micro-Nanofluidics Lab – Dr. Perez-Castillejos

Micropatterning for eye cell transplants



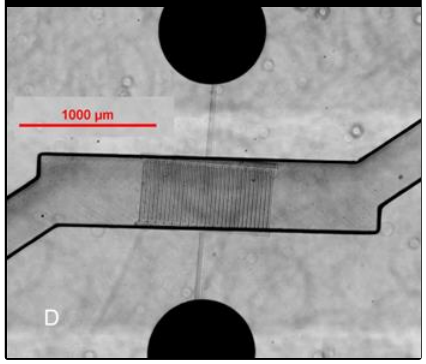
Flexible thick metallic electrodes

With Applications in:

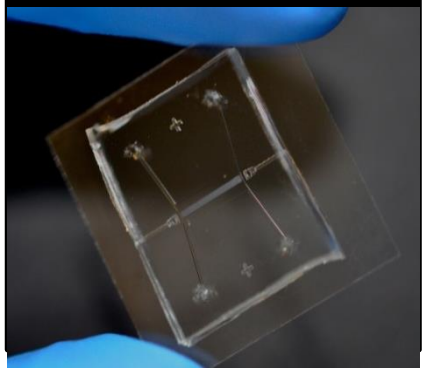
- Tissue Engineering
- BioMEMS and Bio-sensors
- Technology creation and development
- Educational Tools in Micro- and Nanotechnologies
- Intercellular communication

Funding from NSF.

Micro-electric hybrid devices



Opto-fluidic hydrogel device

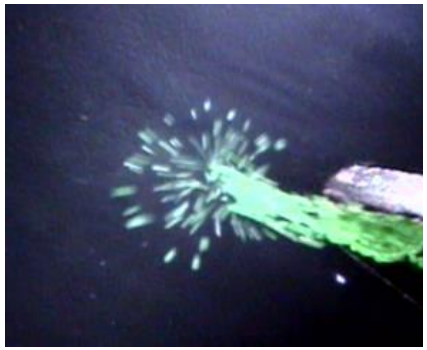


F. Kung, **A.B. Shrirao**, **R. Perez-Castillejos**, and E. Ellen Townes-Anderson. *Positional Effects on Synaptic Connectivity between Photoreceptors*, Integr. Biol. 2015. (published online)

R. Gomez-Bule, **R. Broto Cervera**, **C.-M. Hsiao**, **R. Perez-Castillejos**. *Integration of Indium Micromirrors for Biosensing Applications*, Em. Mat. Res. 2013, 2(4):181-185; doi: **10.1680/emr.13.00008**.

A.B. Shrirao, A. Hussain, C.H. Cho, and **R. Perez-Castillejos**. *Adhesive-Tape Soft Lithography for Patterning Mammalian Cells: Application to Wound-Healing Assays*, BioTechniques 2012, doi: **10.2144/000113928**. (Selected 1of 7 highlights of 2013 by The Scientist).

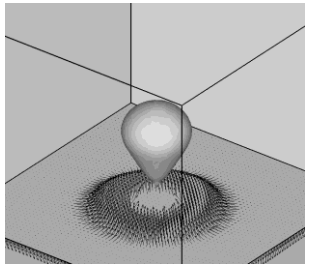
Micro Flow Control Laboratory – Dr. Singh and Dr. I. Fischer

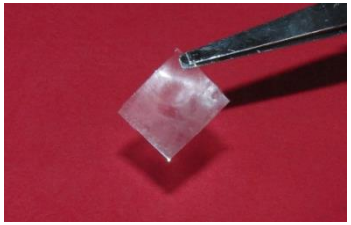


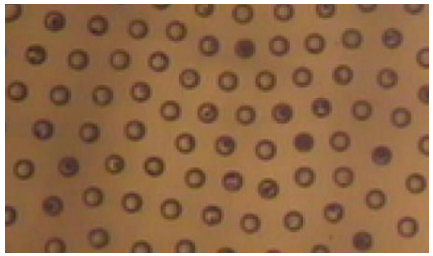
Our group is working on a range of problems involving complex fluids. Our goal is to develop novel theoretical (numerical) and experimental methods for exploring interesting features of dynamics, from both applied and fundamental points of views. At present our work focuses on:

- Electric field assisted self-assembly of particles
- Manipulation deformable particles : biological cells, drops, bubbles, etc., by externally imposed flows and electric fields
- Dispersion of particles on fluid-liquid interfaces
- Computational fluid dynamics of Newtonian, viscoelastic and electrorheological fluids

Website: http://centers.njit.edu/mfcg/research/self-assembly.php







Funding from NSF

Selected publications:

P. Singh, et al., *Scientific Reports* 4, 7427; DOI:10.1038/srep07427 (2014).

N. Musunuri, D. Codjoe, B. Dalal, I.S. Fischer and P. Singh, *KONA*, 31, 135-145 (2014).

P. Singh, M. Hossain, B. Dalal, S.K. Gurupatham and I. Fischer, *MRC*, 45, 54– 57 (2012).

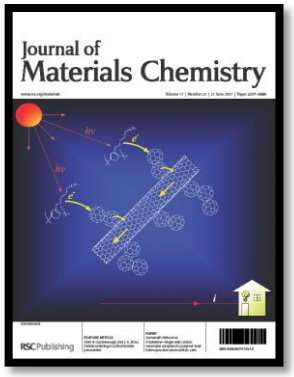
S.K. Gurupatham, et al., *Particle Technology*, 217, 288–297 (2012).

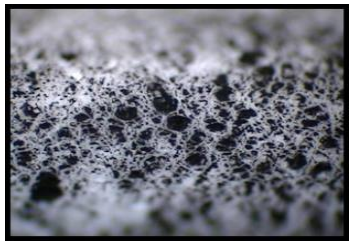
P. Singh, D.D. Joseph and N. Aubry, *Soft matter,* 6, 4310–4325 (2010).

P. Singh, D.D. Joseph, S.K. Gurupatham, B. Dalal and S. Nudurupati, *PNAS*, 106, 19761-19764 (2009).

C. Verdier, C. Couzon, A. Duperray and P. Singh, *Journal of Mathematical Biology*, 58, 235-259 (2009).

Nano Carbons and Analytical Chemistry – Dr. Mitra

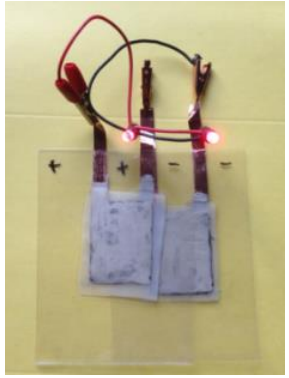


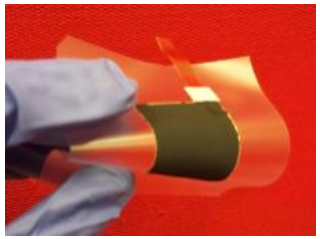


With Applications in:

- Desalination and Water Treatment
- Fate and Biological Effects of Nano Materials
- Flexible Batteries
- Composites and Coatings
- Catalysts and Adsorbents
- Membranes
- Solar Cells
- Chemical Analysis and Sensors

Funding from – NIEHS, US DOE, NSF, NIH, US EPA, US Army.





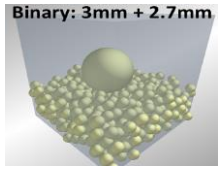
Lau, Xinbo C., Zhiqian Wang, and Somenath Mitra. *Solar Energy Materials and Solar Cells* 128 (**2014**): 69-76.
Chintal Desai, Kun Chen and Somenath Mitra. *Environ. Sci.: Processes Impacts*. 16 (**2014**): 518-523.
Zheqiong Wu, Raymond F. Hamilton Jr, Andrij Holian, Somenath Mitra. *Carbon*, 68 (**2014**): 678-686.
Bhadra, Madhuleena, Sagar Roy, and Somenath Mitra. *Desalination* 341 (**2014**): 115-119.
Zhiqian Wang, Zheqiong Wu and Somenath Mitra. *Advanced Materials.* 26(**201**4):970-976.

Particle-Process Engineering & Pharmaceutical Nanotechnology – Dr. Bilgili

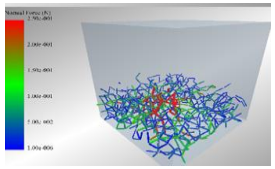
With Applications in:

- Nanoparticles & Nanocomposites
- Bioavailability Enhancement & Modified Release of Drugs
- Sterile-filterable Drug Suspensions
- Colloids, Pigments, and Coatings
- Bottom-up & Top-down Particle Formation Processes
- Process Intensification, Modeling, & Optimization

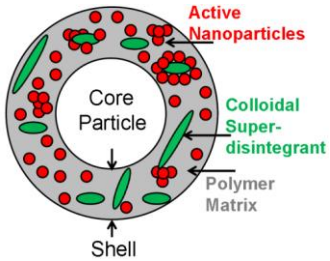
Funding from – NSF, Boehringer-Ingelheim, Catalent Pharma

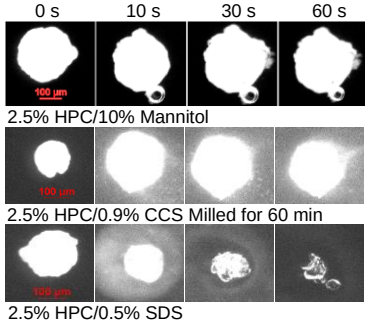


Multi-Scale Process Models

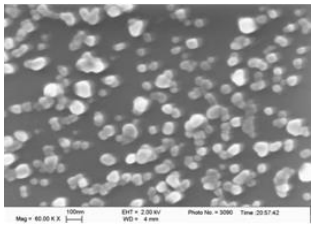


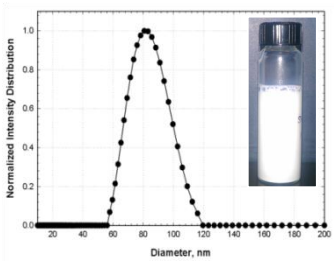
Surfactant-Free, Redispersible, Nanocomposite Microparticles for Fast Active Agent Delivery



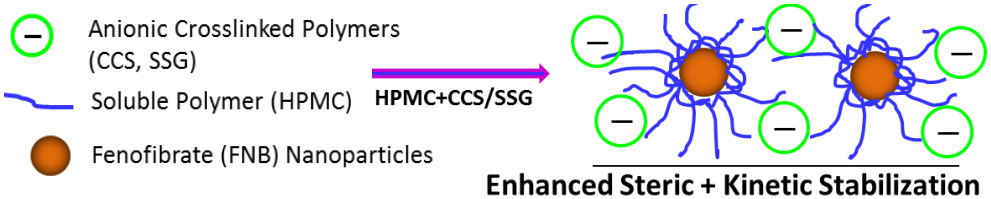


Intensified Wet Milling for Preparation of Sub100 nm Drug Particles and Sterile-filterable/Injectable Nanosuspensions



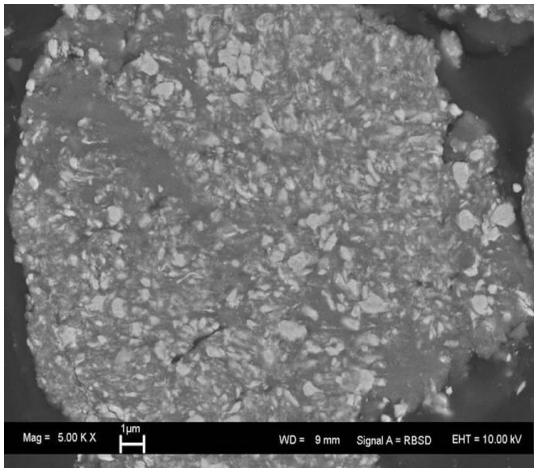


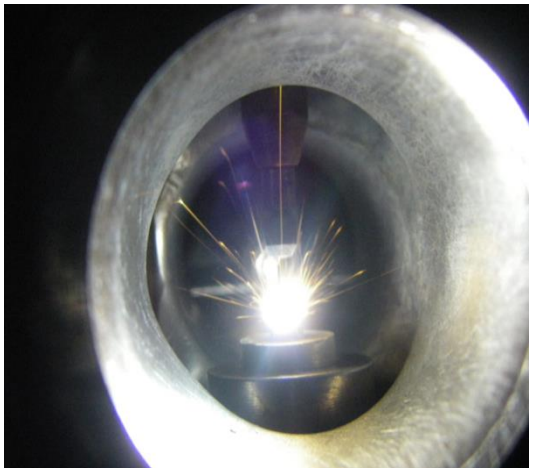
Novel Nanosuspension Stabilization with Swellable Polymers

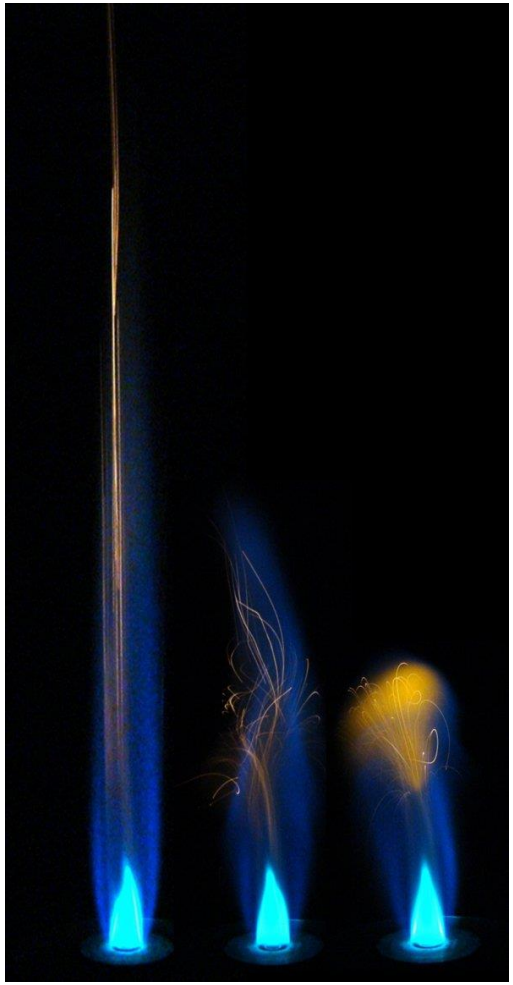


Afolawemi Afolabi, Olakemi Akinlabi, and Ecevit Bilgili. *European Journal of Pharmaceutical Sciences* 51 (**2014**) 75-86.
Anagha Bhakay, Mohammad Azad, Emmanuel Vizzotti, Rajesh N. Dave, and Ecevit Bilgili. *Drug Development and Industrial Pharmacy* 40 (**2014**) 1509-1522.
Maxx Capece, Ecevit Bilgili, and Rajesh Dave. Chemical Engineering Science 117 (**2014**) 318-330.
Ecevit Bilgili (Primary Inventor), Anagha Bhakay, Mohammad Azad, and Rajesh Dave. US Patent Application (**2013**) US 2013/0295190 A1, Pending.
Ecevit Bilgili and Afolawemi Afolabi. *International Journal of Pharmaceutics* 439 (**2012**) 193-206.

Reactive Nanomaterials Lab – Dr. Dreizin







- Research focuses on preparation of **new metal-based composite materials**
- Materials are studied using **x-ray diffraction, electron microscopy, thermal analysis** and other techniques
- **Ignition and combustion** of materials is studied using custom-designed laboratory experiments
- Applications of the materials include energetic formulations (**propellants, explosives, pyrotechnics**), and materials for **in-situ energy sources**.

Funding from DOD

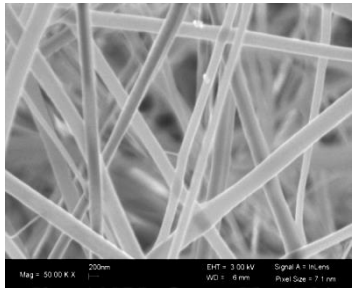
Contact: dreizin@njit.edu; 973-596-5751; http://web.njit.edu/~dreyzin/

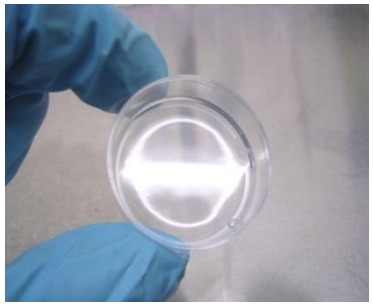
Stem Cells and Tissue Engineering Lab – Dr. Cho

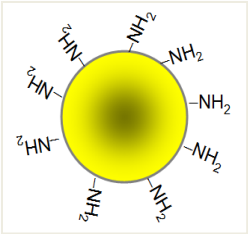
With Applications in:

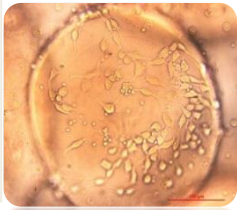
- Polymeric Biomaterials
- Scaffold design and fabrication
- Tissue Engineering
- Injectable, multifunctional hydrogels for tissue repairs
- Stem cell bioengineering
- Micropatterning of cells and ECM

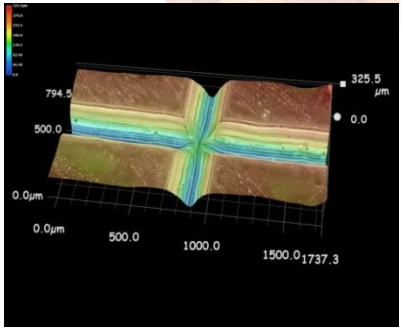
Funding from – NIH, Coulter Foundation, BD Biosciences









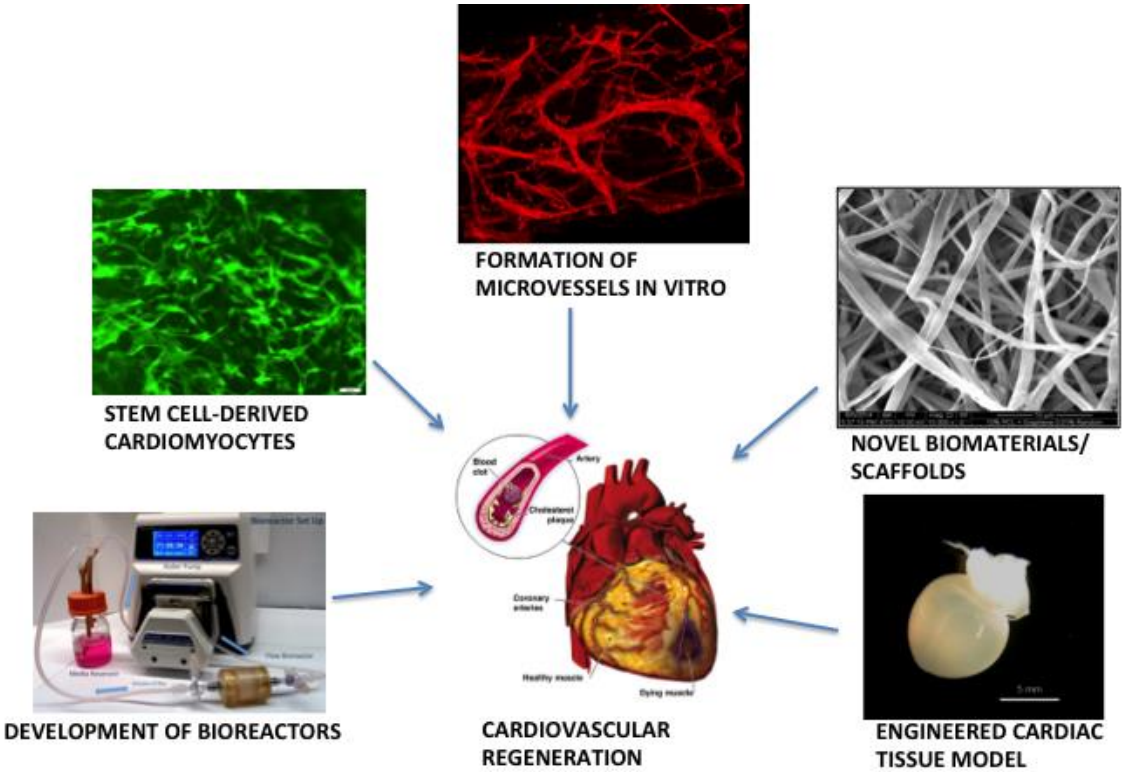


Nolan Skop, Frances Calderon, Steven Levison, Chirag Gandhi, Cheul H. Cho, **Acta Biomaterialia** [2013)
Derek Yip, Cheul H. Cho, **Biochemical and Biophysical Research Communications** (2013) 327-332
Ali Hussain, George Collins, Derek Yip, Cheul H. Cho, **Biotechnology and Bioengineering** (2013) 637-647
Nolan Skop, Frances Calderon, Cheul H. Cho, Chirag Gandhi, Steven Levison, **Journal of Tissue Engineering and Regenerative Medicine** (2013)
Nolan Skop, Frances Calderon, Cheul H. Cho, Chirag Gandhi, Steven Levison,, **Molecular and Cellular Therapies** (2014)

Cardiovascular Tissue Engineering and Stem Cell Lab – Dr. Alice Lee

◆ RESEARCH AREAS

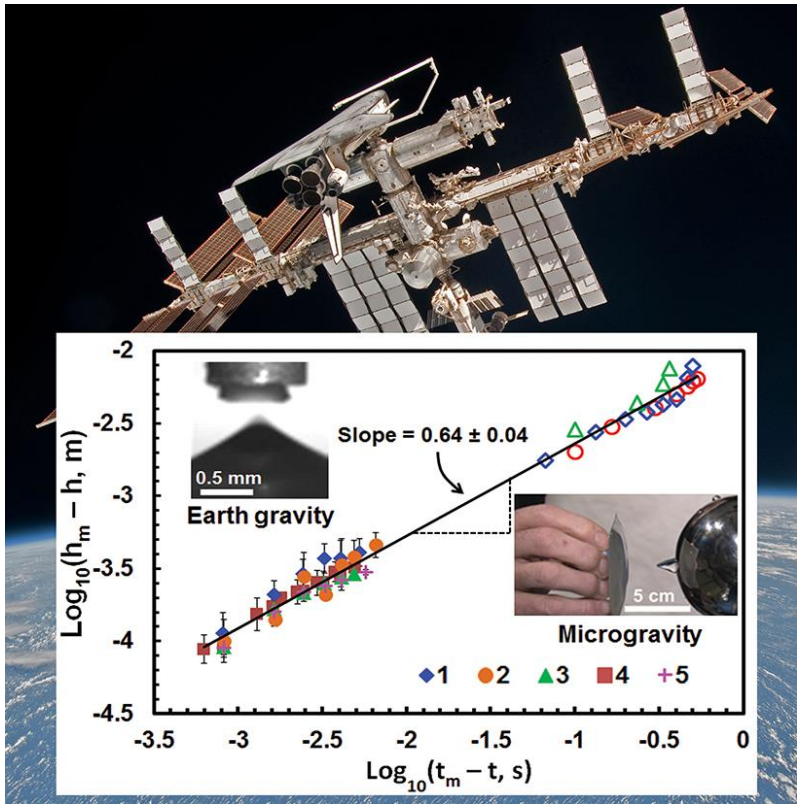
- To develop functional engineered cardiovascular tissues using novel biomaterials and custom-designed bioreactor systems
- To develop novel strategies to enhance the growth of cardiac and vascular tissues *in vitro* by examining the effects of physical, mechanical, and chemical stimuli on stem cell differentiated cardiac and vascular cells using 3D engineered tissue models
- To investigate tissue engineering approaches to develop microvascular formation *in vitro*
- To develop vascularized insulin-producing tissues for diabetes treatment



Electric Field Driven Phenomena in Colloids under Microgravity in ISS – Dr. Khusid

Motivation:

Understand underlying physics by removing masking effects of gravity (particle settling, buoyancy driven convection, etc.)



Elele, Shen, Khusid (**NJIT**), Pettit (**NASA astronaut**), *Physical Review Letters* 114, 054501, **2015**

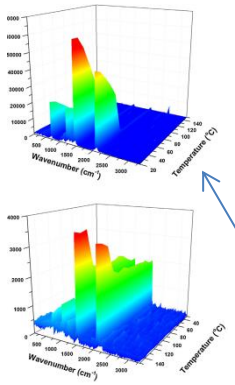
Applications in micro- & nano-fluidics for:

- Aerospace
- Medical diagnostics
- Biotechnology
- Complex materials
- Drug delivery

Funding from NASA

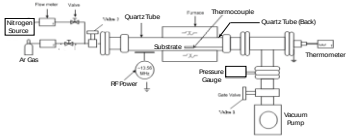
Thermo-Chromic Paints and Bio Fuel Cells –Dr. Iqbal

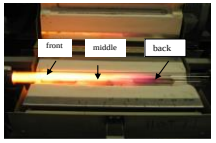
- **Thermo- and Chemo-chromic sensing paints and inks**



Raman spectra as a function of increasing and decreasing temp

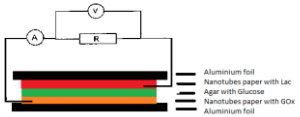
- Plasma and electrochemical synthesis of high energetic material: Poly-nitrogen
  - PN clusters as oxygen reduction catalyst for fuel cells

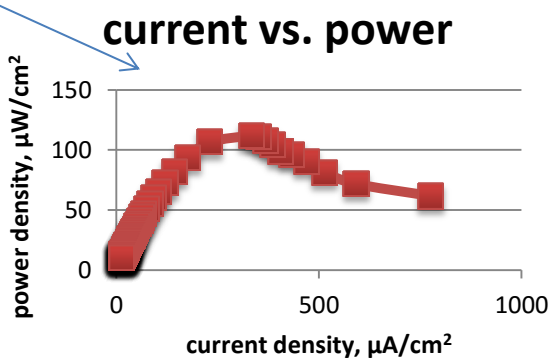


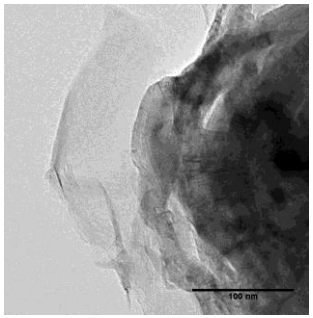


Z. Wu, et al , N_8^- Polynitrogen Stabilized on Multi-Wall Carbon Nanotubes for Oxygen-Reduction Reactions at Ambient Conditions, *Angew. Chem. Int. Ed.* **2014**, *53*, 12555; T.G. Manning and Z. Iqbal, Nitriding of Carbon Nanotubes, *US Patent* 8,317,978B1 ,**2012**.

- **Flexible biofuel cells**
  - ARDEC, NSF-planned







TEM of large scale CVD graphene

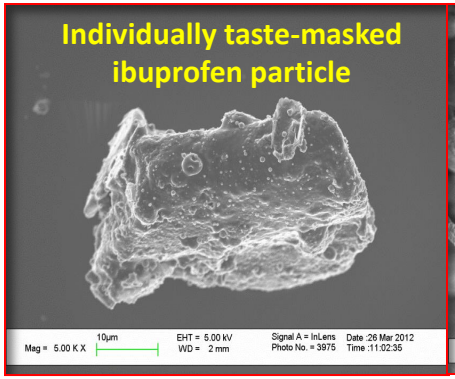
- **CVD of large scale graphene and boron nanostructures**

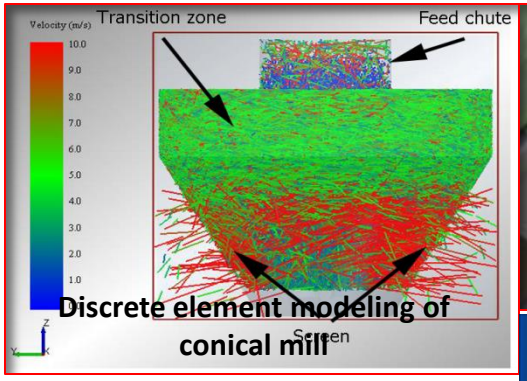
Funding – US Army ARDEC, SERDP, US DOE

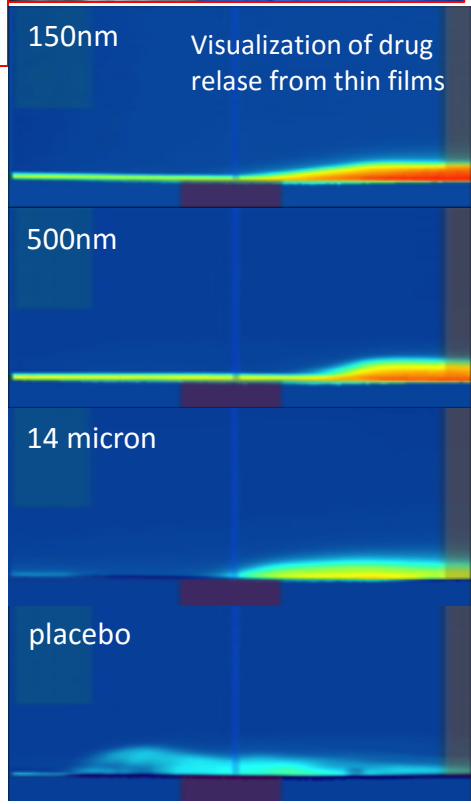
Particle engineering for improved particulate composites

Dr. Rajesh N. Davé

Funding: NSF, Army/Navy, Industrial collaborations







- Research focuses on preparation of **nano and micro particulate composite materials** for pharmaceutical, agrochemical, electronic, catalytic, and specialty chemicals
- Research infrastructure includes advanced particle and materials **characterization and processing** equipment
- Our graduate students collaborate with **national and international groups** and are part of NSF funded multi-university Center
- Our alumni are working in major industrial companies and in US academia

Dr. N.L. Jackson

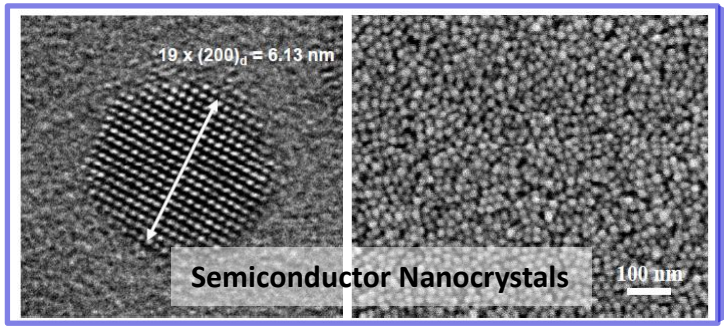
Facilitating dune building on developed shorelines (NOAA)

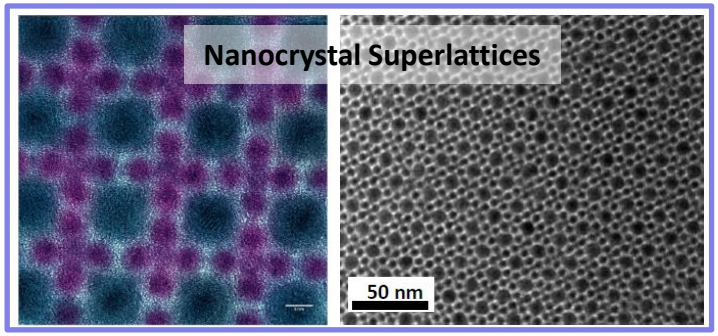
- Constraints on aeolian sediment transport across backshores
- Effects of beach management practices on foredune growth

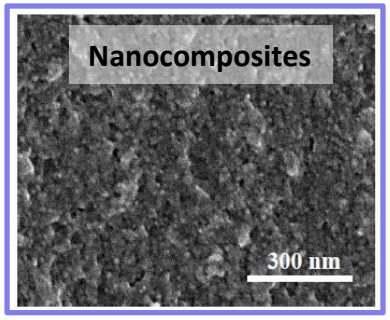
Estuarine beach dynamics (NOAA, NSF, NPS, NGS)

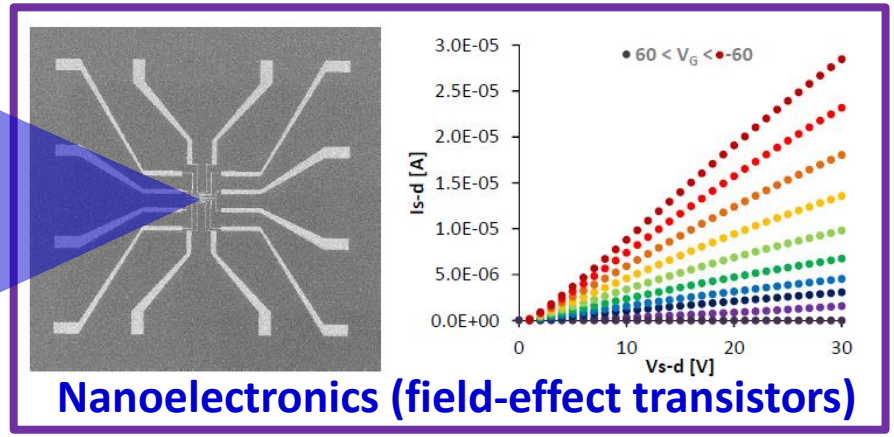
- Sediment transport by waves and swash
- Using nourishment to restore geomorphic and biotic interactions
- Effects of shore protection structures on beach morphology and habitat migration

Nanoelectronics and Energy Conversion Lab (Dr. Ko)

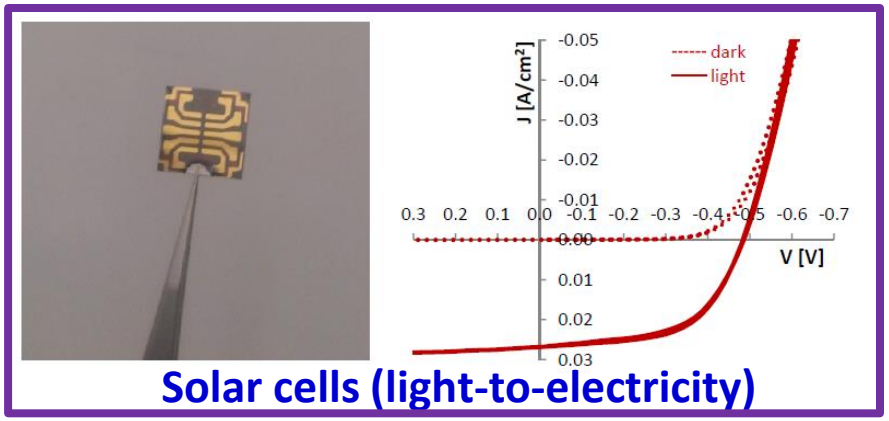




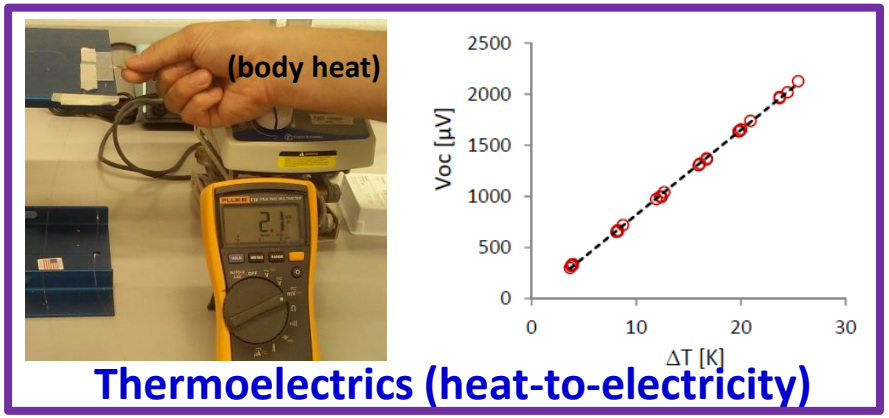




Nanoelectronics (field-effect transistors)



Solar cells (light-to-electricity)



Thermoelectrics (heat-to-electricity)

References

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  (2) D. -K. Ko *et. al., ACS Nano*, 2011, 5, 4810-4817
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- Thermoelectrics: (1) D. -K. Ko *et. al., Nano Lett.*, 2011, 11, 2841-2844
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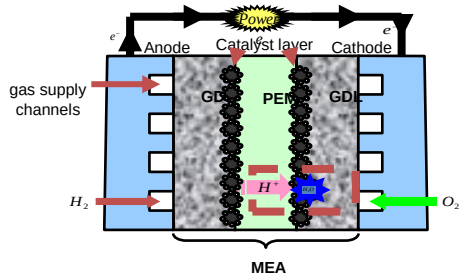
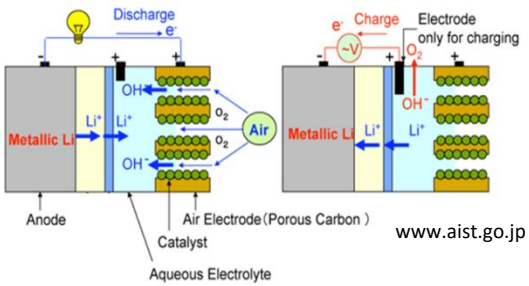
Advanced Energy Systems and Microdevices Lab

Dr. Eon Soo Lee

Fuel Cell



Metal-Air Battery



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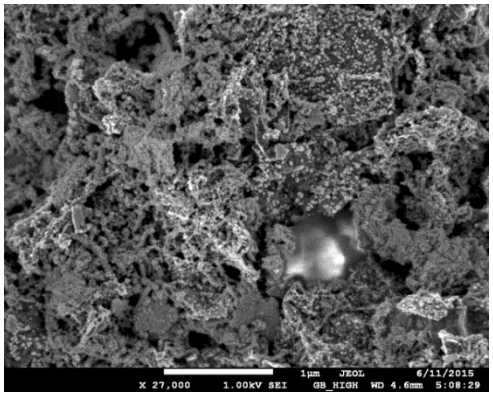
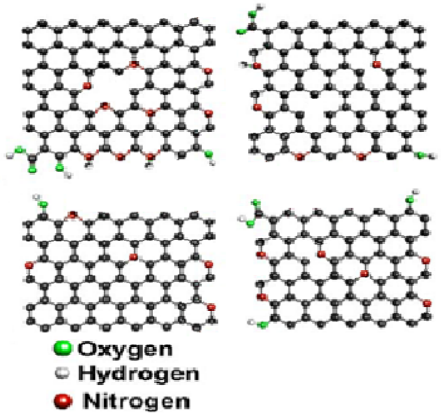
New Non-PGM Catalysts for Electrochemical Systems



- **With Applications in:**
- Fuel cell technology
- Metal-air battery
- Hydrogen Production
- Ammonia Synthesis
- Petroleum Processing
- Hydrogenation/Dehydrogenation Reactions
- Polymerization Reactions
- Automobile exhaust gas purifying

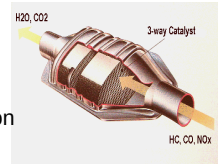


- Funding from NJIT
- Support from NJIT, Brookhaven National Lab,
- Rutgers, CUNY-ASRC

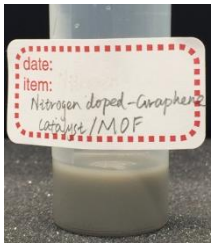
Fuel Cell Car

Petroleum Process

Catalytic converter for gas purification



www.aa1car.com



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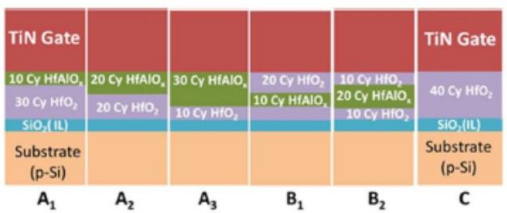
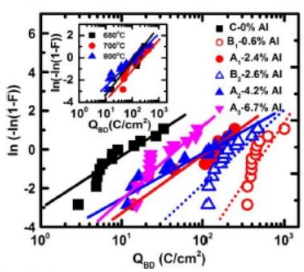
Patent Application: 15-034 [NJIT] - New Graphene-Based Non-PGM Catalysts with High Porosity Carriers for Electrochemical and Industrial Applications

Device Characterization Lab – Dr. Misra



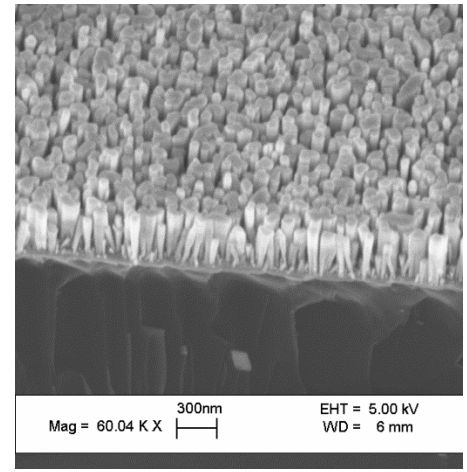


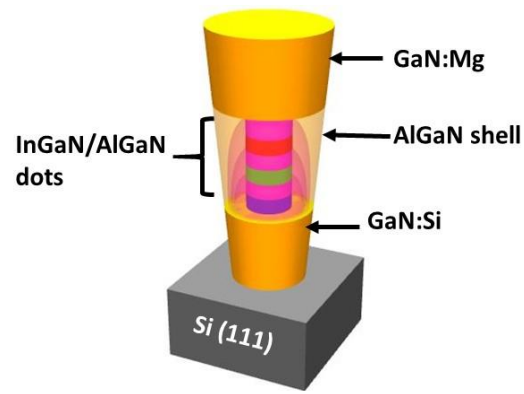
With Applications in:

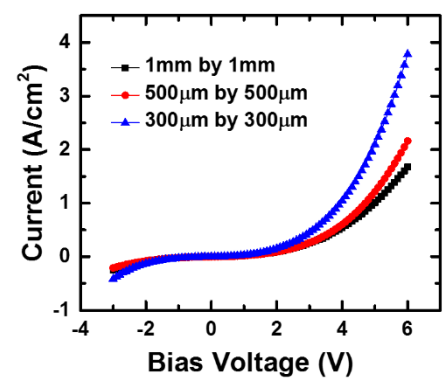
- Nanoscale CMOS devices
- Semiconductor nanostructures
- Electrical characterization
- NBTI, PBTI, SILC, TZDB, TDDB, interface states and low temperature characterization
- Defect Characterization of Thin-film (CdTe) and Silicon Solar Cells

Funding from-

TEL Technology Center, America, LLC







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