Academic and Research Highlights Fall 2020

School of Materials Science & Engineering

Naresh Thadhani
Professor and Chair
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MSE Over the Years

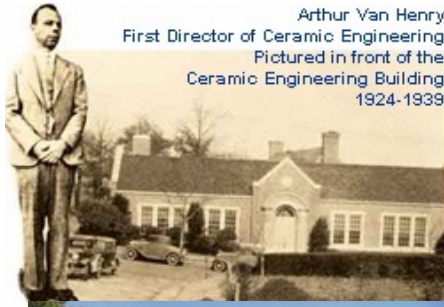
1897 President Lyman Hall founded A. French School of Textile Engineering – 3rd School to open at GT

1924 Advent of kaolin industry - School of Ceramic Engineering formed with B.S. degree program

1985 School of Materials Science & Engineering formed from merger of Ceramics and Metallurgy

2003 Textile Engineering School renamed School of Polymer, Textile and Fiber Engineering (PTFE)

2010 Merger of PTFE with Ceramics & Metallurgy into largest and most diverse MSE program in nation



The Present MSE – Faculty by the Numbers

- **41** Faculty, **9** joint appts., 35.57 FTE, 2 lecturers
- 34 Courtesy and Adjunct Faculty
- 6 Chair & 5 Regents' Professors
- 9 Female (1 Chaired) & 3 URM Faculty
- 16 AFOSR/DOE/ONR/NSF/ Career/YIP Awards
- 1 NAE (US), 1 NAE China
- 22 Faculty Prof. Soc. Fellows (41 Fellowships)

The Present MSE – Students by the Numbers

UNDERGRADUATE

- 275 total: 35%Female/65%Male
- 44% GA/ 56% Out of State/ 12% International
- 100% Co-op/Internship/Research
- USN&WR MSE Rank – 4th

GRADUATE

- 204 total: 76%PhD/24%MS; 37%Female/63%Male
  63%Domestic/37%International
- 20-25 Non-MSE students
- 10% Internships (Industry & Natl.Labs)
- USN&WR MSE Rank – 9th

Materials Science & Engineering (MSE) Programs

- **UG - B.S. Degree:** 132 hours
  - 21 hours in concentration and 6 hours of capstone design
  - Conc: Bio-Materials, Polymer & Fiber Materials, Structural and Functional Materials
  - Options: Co-op, Research, Study-abroad, Business
- **GRAD – Ph.D.**
  - 2 core + 5 elective + 3 Minor + Seminar, Qualifier, Proposal, Dissertation defense
  - Internship, Entrepreneurship, Teaching Practicuum
  - Matls Science & Eng; Bio-Eng.

Materials Certificate Programs

Computational Materials Science & Engineering

CREATING THE NEXT® *in materials*

Georgia Tech School of Materials Science and Engineering

The MILL - Materials Innovation and Learning Laboratory

An Open-access Make & Measure Space

THE MILL

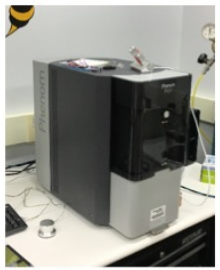
Materials Innovation & Learning Laboratory

The equipment for the MILL has been acquired with the generous support of the following sponsors.

3M · Art and Patricia Cox · HYREL 3D · Georgia Institute of Technology · Georgia Tech College of Engineering

HEADQUARTERS
Erskine Love Manufacturing Building
Room 176
For more info, email:
themillgt@gmail.com

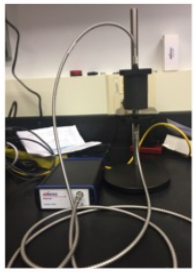
Ceramic Processing



SEM/EDX

XRD

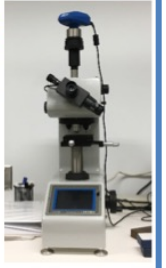
ATR-FTIR



UV/Vis

3D Printers

Mechanical



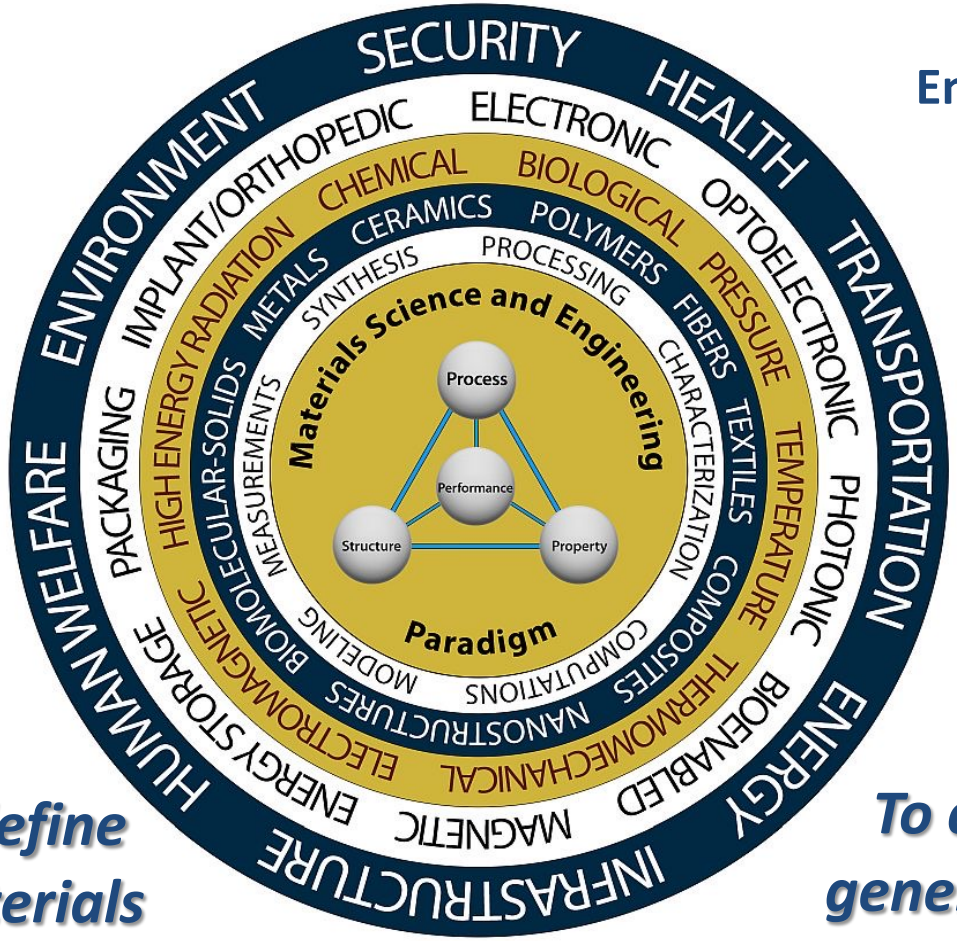
Hardness

MSE Education and Research Paradigm

Enabling Discipline

Curriculum plus Education

Experiential Learning



Entrepreneurship & Innovation

Discovery of New Materials

Deployment in New Applications

VISION

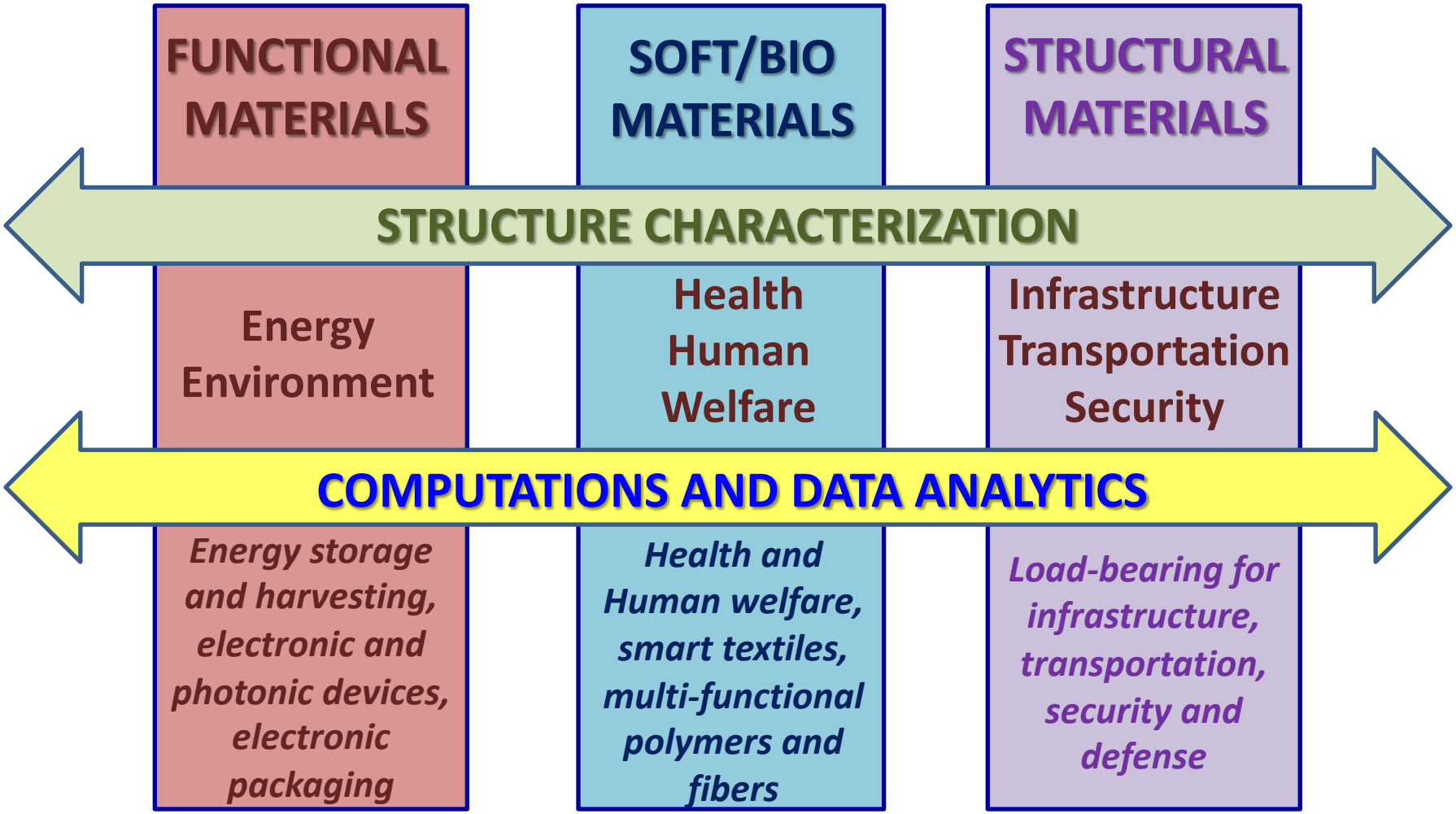
MSE at GT will define the future of materials science & engineering through academic & research excellence

MISSION

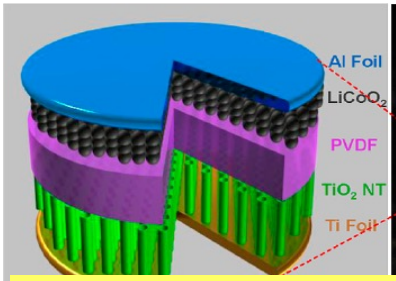
To create the next generation of leaders through education, research innovations, and service to society

TOPICAL WORKING GROUPS IN MSE

Materials – Metals, ceramics, polymers, fibers, textiles, composites, nanostructured, and bio-inspired materials

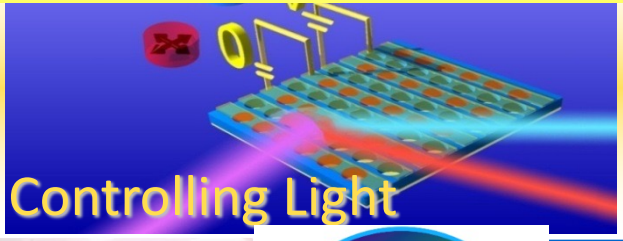


The World of Materials Research in MSE @ GT



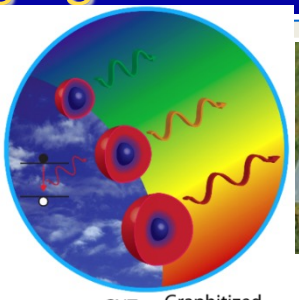
Energy harvesting and storage

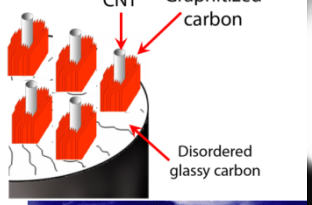
Optoelectronic Communications

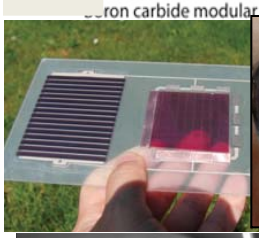


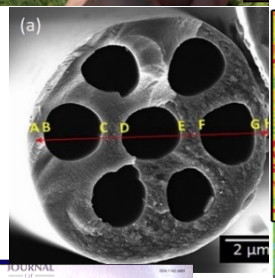
Security

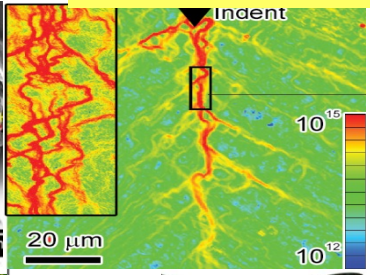
Health & Human Welfare







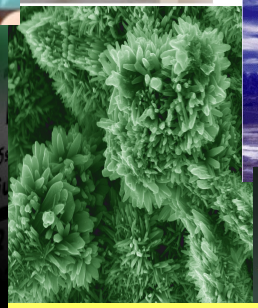




Environment

Infrastructure

Materials Discovery

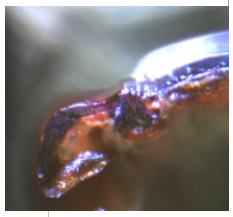


Transportation

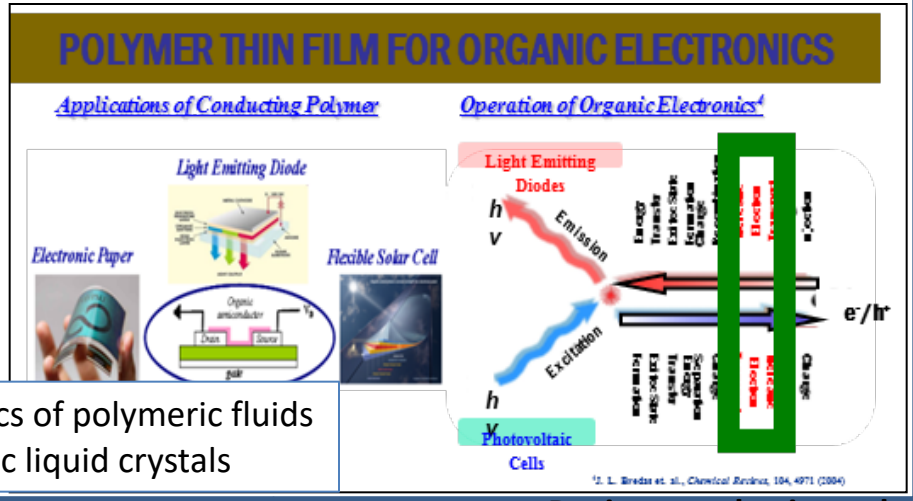
Mimicking Nature

Bio-enabled and Bio-inspired Materials

Vladimir Tsukruk

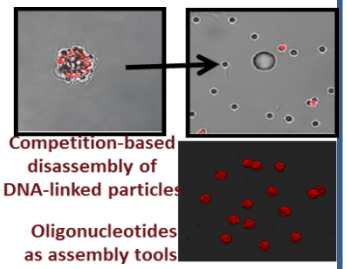


Mohan Srinivasarao

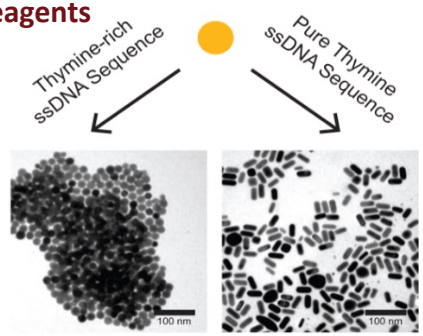


Optics & physics of polymeric fluids & nematic liquid crystals

Valeria Milam

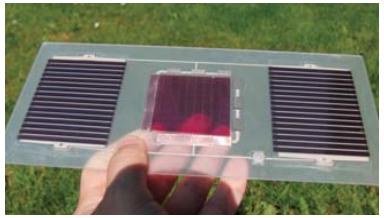


Oligonucleotides Gold Seed **as reagents**



Design, synthesis, and processing of soluble conjugated organic molecules and polymers for electrochemical an solid-state applications

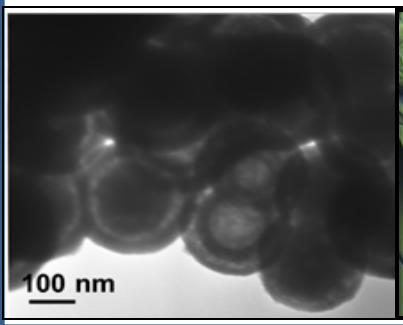
John Reynolds

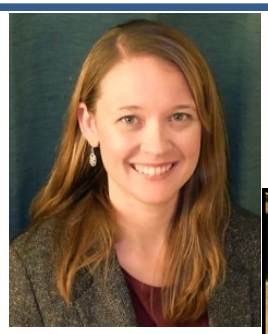


Materials For Health & Human Welfare

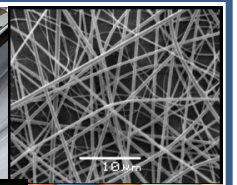
Paul Russo

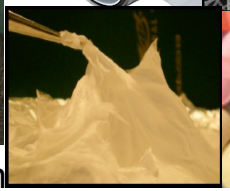
Therepeutic drug delivery

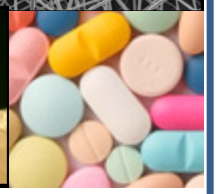


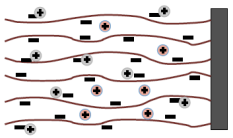


Blair Brettmann

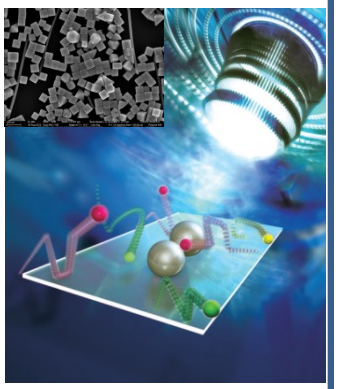


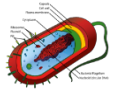


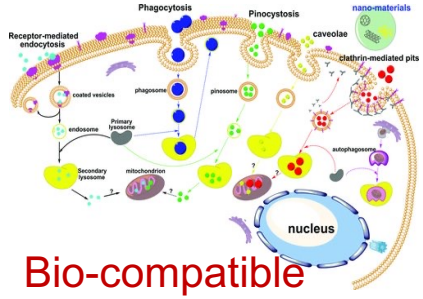




Dong Qin

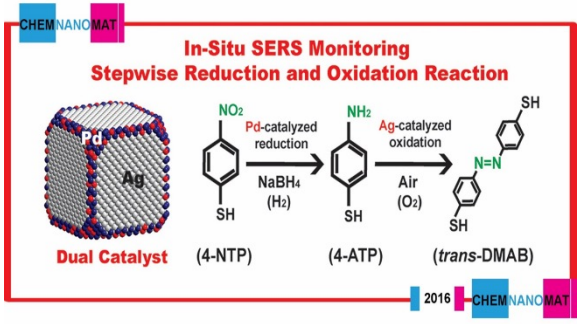


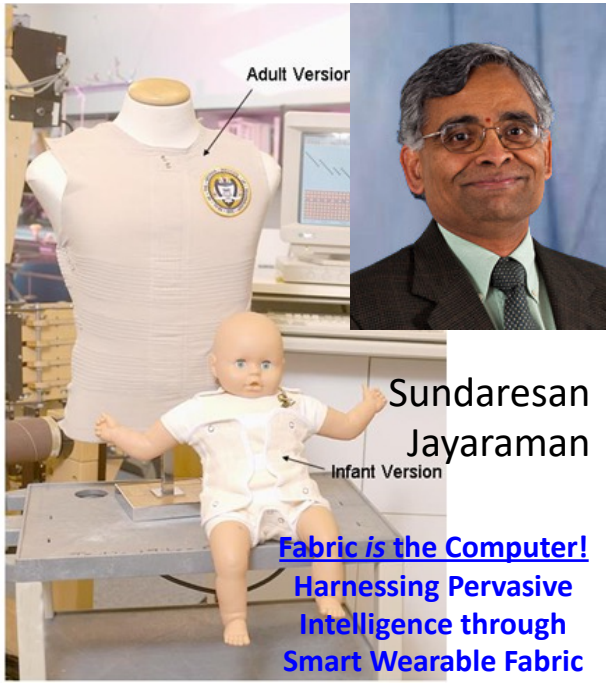




Bio-compatible Nano-platforms

Bimetallic nanocrystals with plasmonic and catalytic properties for applications in surface-enhanced Raman scattering (SERS)

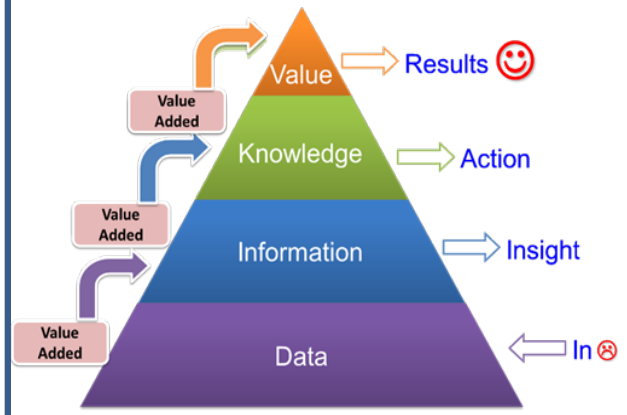




Sundaresan Jayaraman

Fabric *is* the Computer!
Harnessing Pervasive Intelligence through Smart Wearable Fabric

Data-Value Transformation Paradigm

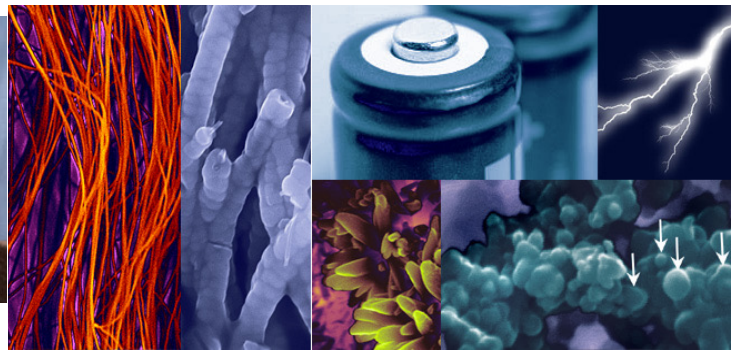


Materials for Energy Storage & Harvesting

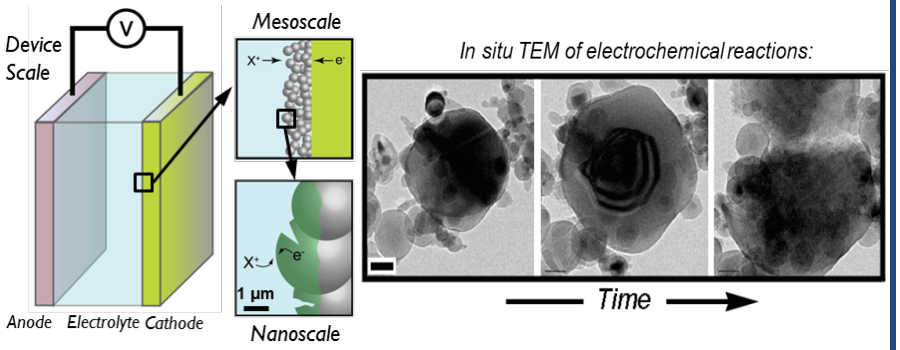
Meilin Liu

Fuel cells, Batteries, Supercapacitors for efficient storage & conversion

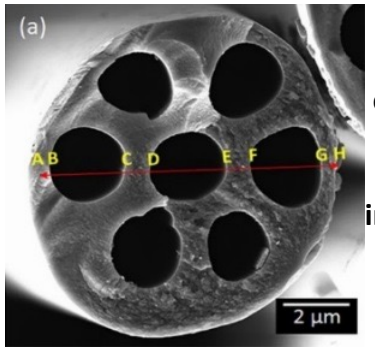
Gleb Yushin



Matt McDowell



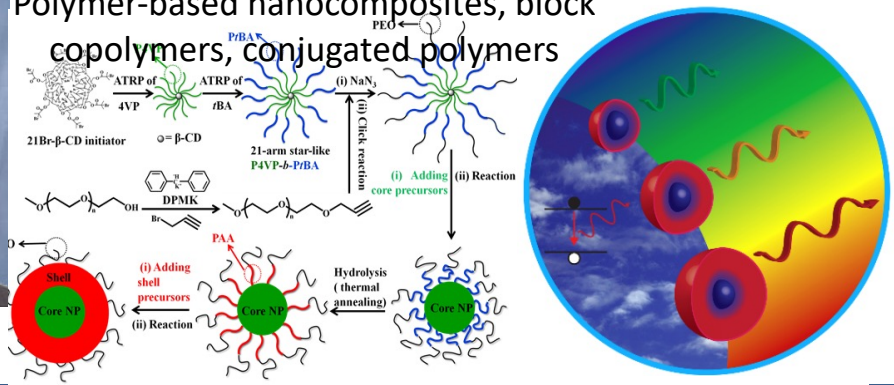
Satish Kumar

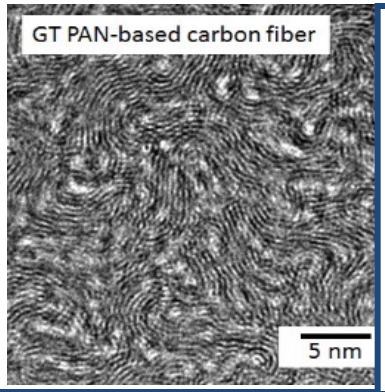


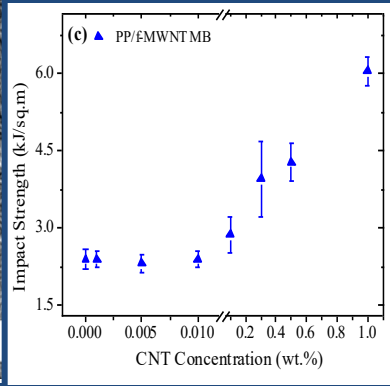
Hollow C-CNT composite fiber with tailored interphases

Zhiqun Lin

Polymer-based nanocomposites, block copolymers, conjugated polymers

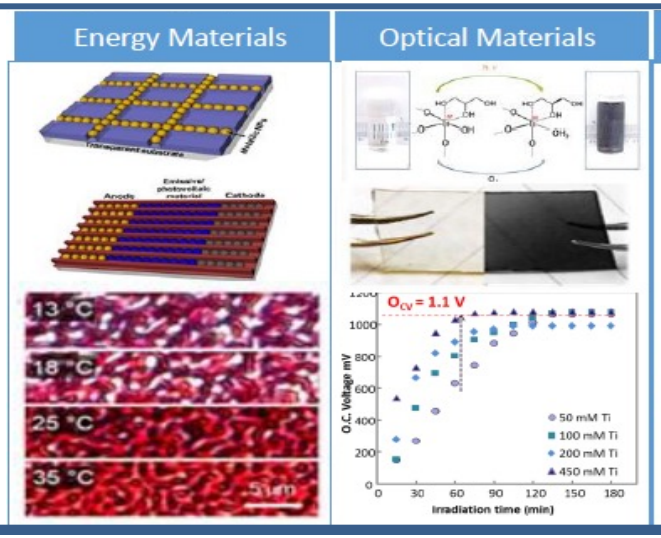




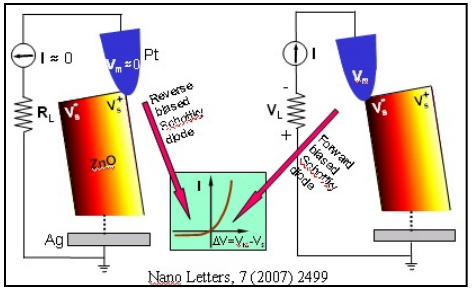


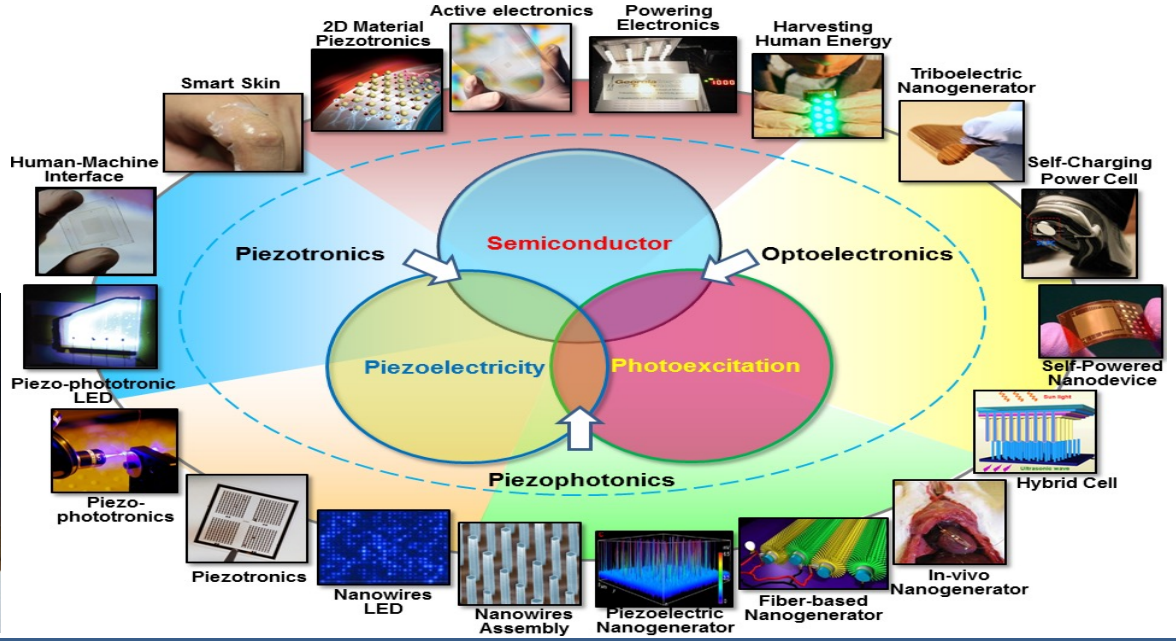
Active Materials & Self-powered Devices

Natalie Stingelin



Zhong Li Wang

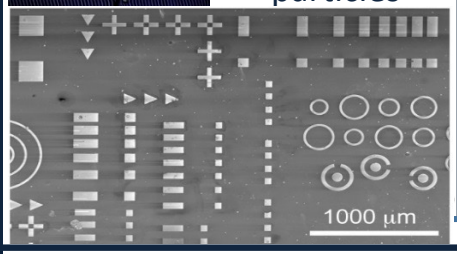


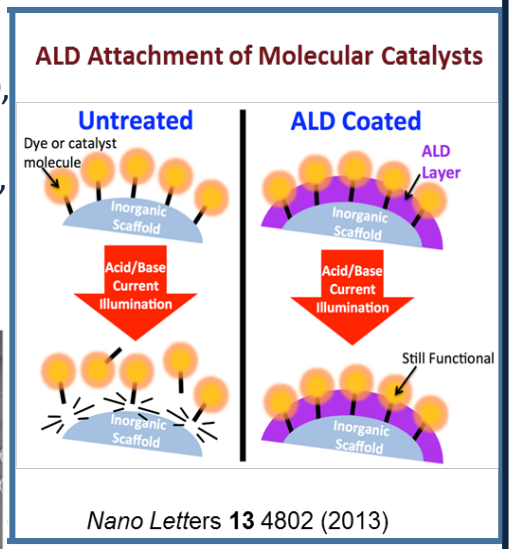


Electronic Devices: Synthesis & Fabrication

Mark Losego

Synthesis via sputtering, ALD, surface polymerization, and colloidal assembly of particles

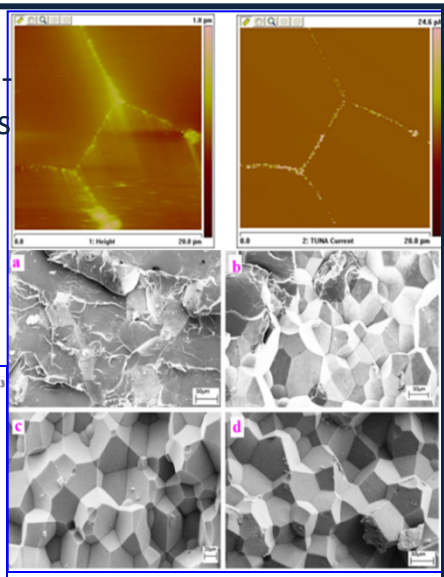


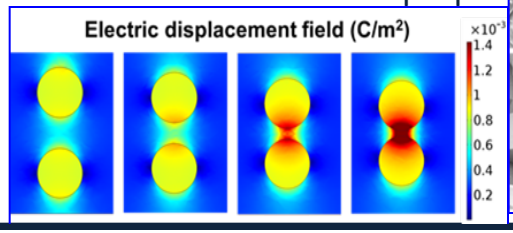


Nano Letters **13** 4802 (2013)

Rosario Gerhardt

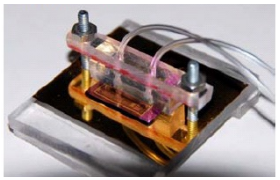
Process-structure-property relations in electronic materials, impedance spectroscopy, dielectric props.

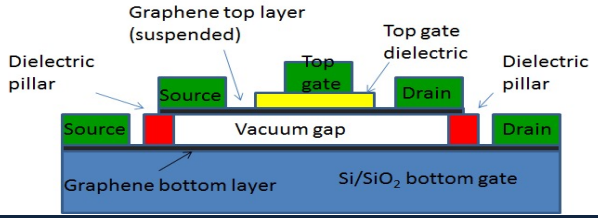




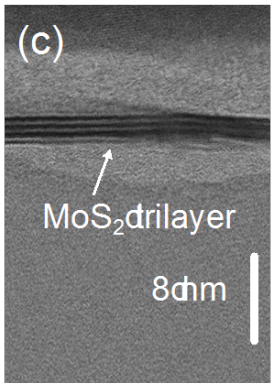
Eric Vogel

Synthesis, structure, and properties of electronic materials and devices





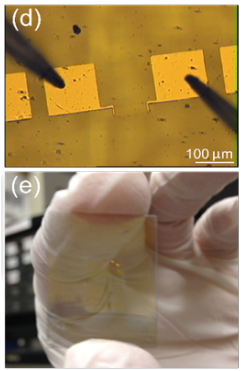
New Synthesis Methods



Chemical Vapor Deposition of MoS_2

Advanced Functional Materials **24**, 6389 (2014)

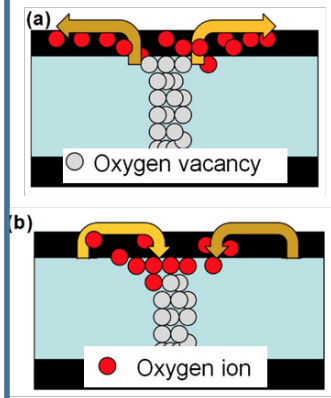
Novel Device Fabrication



Flexible/transparent MoS_2 transistors

ACS Applied Materials & Interfaces **7**, 12850 (2015)

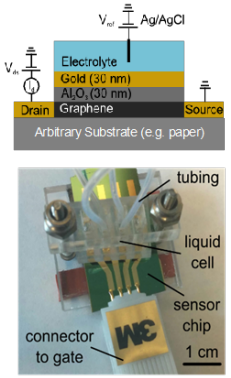
Atomic Scale Mechanisms



Filament formation in metal oxide memory

IEEE Electron Device Letters **35**, 750 (2014)

Applications



Graphene-based biosensor

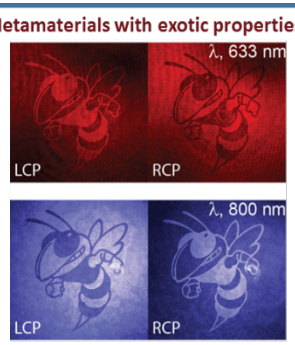
2D Materials **2**, 044008 (2015)

Electronic, Optoelectronic, Packaging & Devices

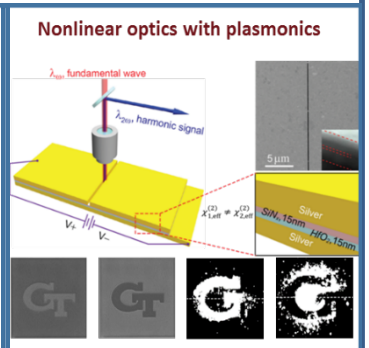
Wenshan Cai

Engineered nanostructures for light manipulation

Nanophotonics, optoelectronics, plasmonic nanodevices, optical metamaterials, integrated photonics, optical sensing



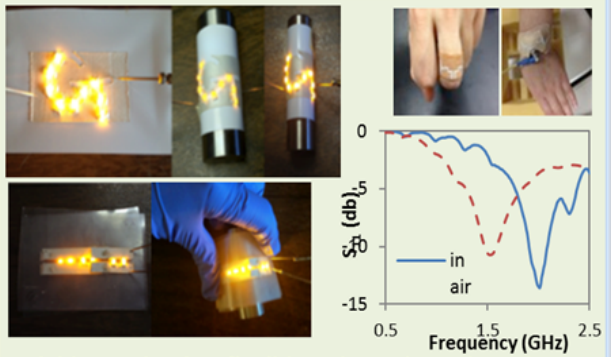
Advanced Materials **27** 1124 (2015)



Nature Materials **14** 807 (2015)

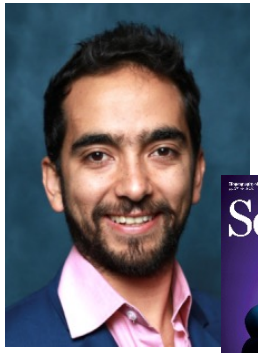
C.P. Wong

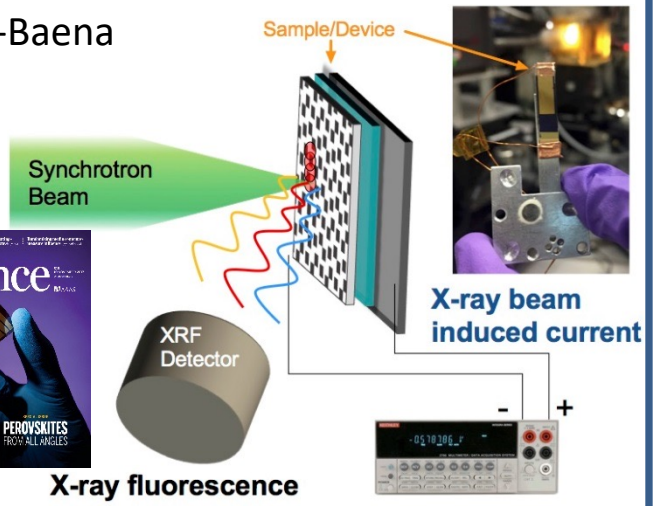
Wearable and printable devices



Highly conductive, flexible polyurethane-based adhesives for flexible and printed electronics

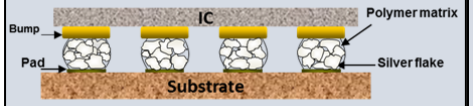
Juan-Pablo Correa-Baena



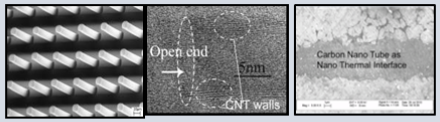


Understanding and controlling low-cost semiconductor electronic dynamics at nanoscale

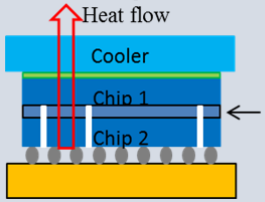
Electrical Interconnects



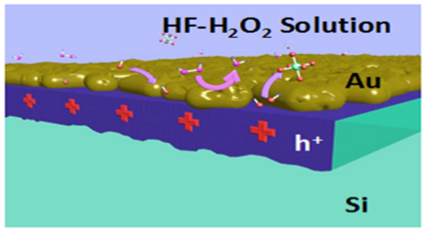
Nano Thermal interface materials (carbon nanotubes)

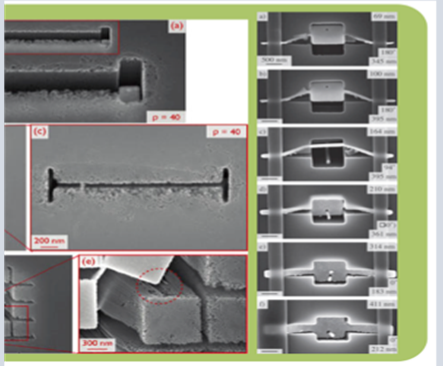


Thermally conductive IC Encapsulant Underfill



3D Nanomanufacturing

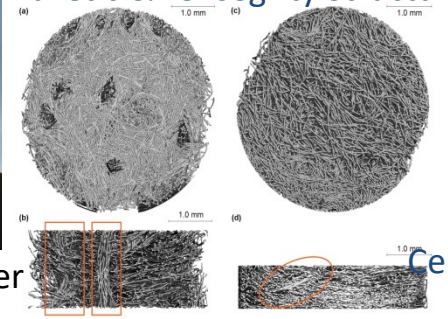




Infrastructure and Transportation

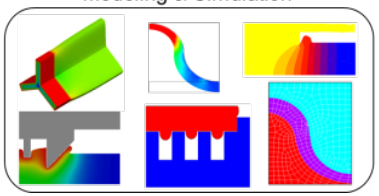
Meisha Shofner

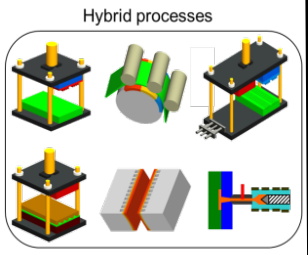
Auxetic & Tensegrity Structures



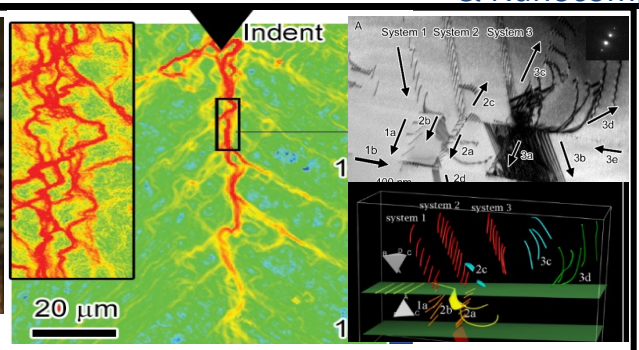
Cellulosic Nanomaterials & Nanocomposites

Donggang Yao

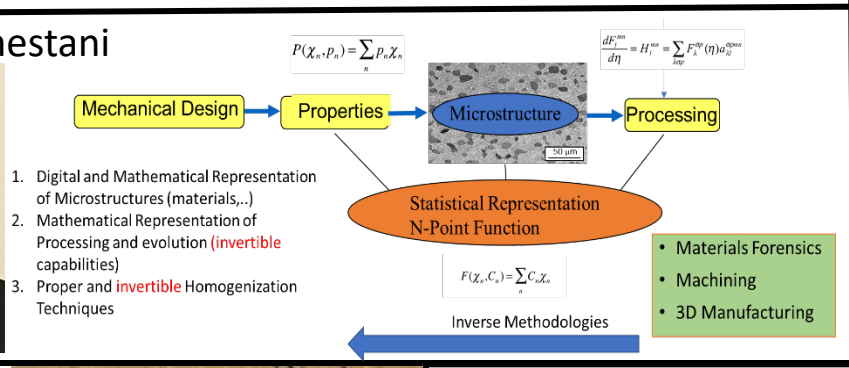




Josh Kacher



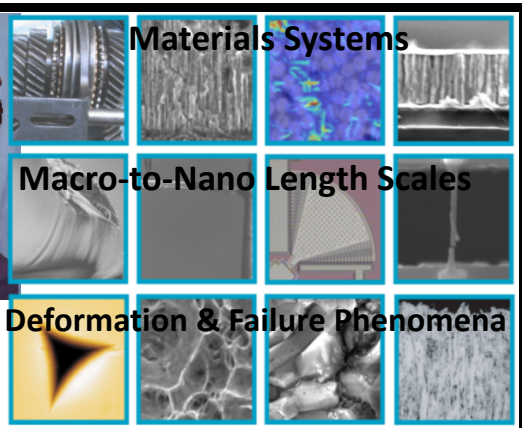
Hamid Garmestani



1. Digital and Mathematical Representation of Microstructures (materials,..)
2. Mathematical Representation of Processing and evolution (invertible capabilities)
3. Proper and invertible Homogenization Techniques

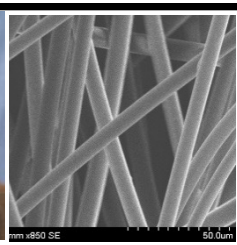
- Materials Forensics
- Machining
- 3D Manufacturing

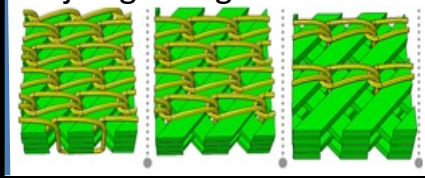
Chris Muhlstein



Preet Singh

Youjiang Wang





Computational Materials Science and Design

Dave McDowell

- Multiscale modeling approaches can be used to inform models at high scales with data generated using sub-models simulated at finer scales

Macroscale
Scale: >1mm
- Empirical Models (e.g. Paris law)
- Microstructure-sensitive plasticity macro models
- Informed

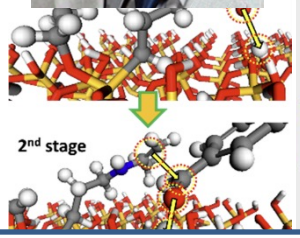
Mesoscale(s)
Scale: ~100 nm – <1mm
- Dislocation dynamics using Coarse Grained MD
- Crystal Plasticity

Nanoscale
~1-100nm
- Molecular Dynamics

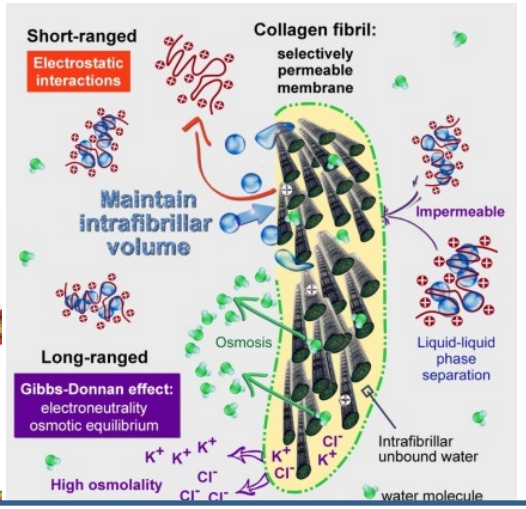
20 μm

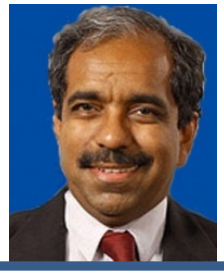
Funding from NSF, DOE NEUP, ONR, NAVAIR

Seung Soon Jang



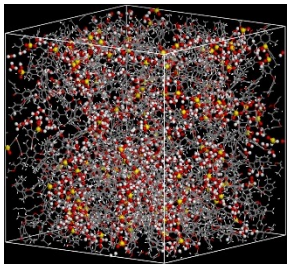
Collagen Mineralization



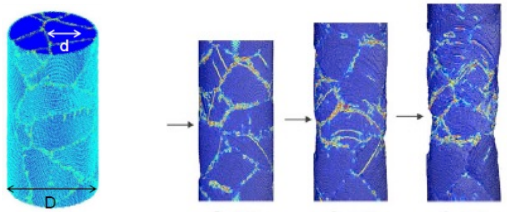


Karl Jacob

Experimental & computational approach to study material behavior

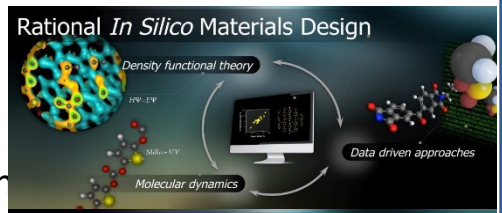


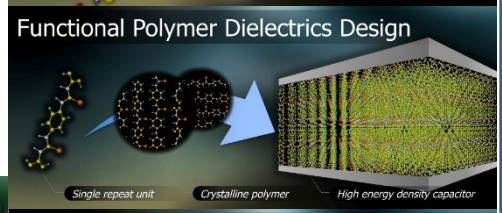
Mo Li Electromigration in Nanoscale

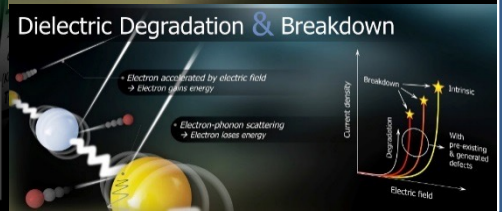


Rampi Ramprasad

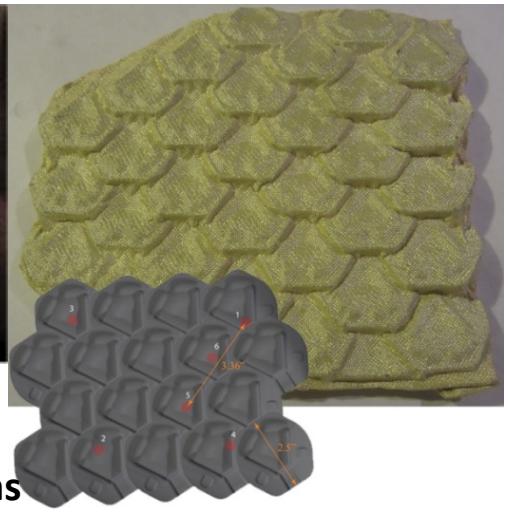
Computation Aided Materials Discovery



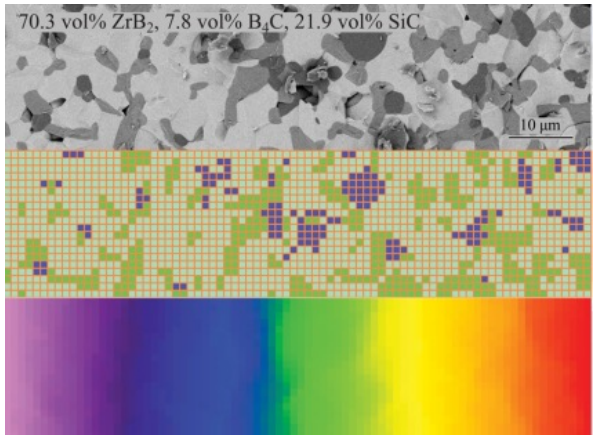




Security: Materials Under Dynamic Extremes

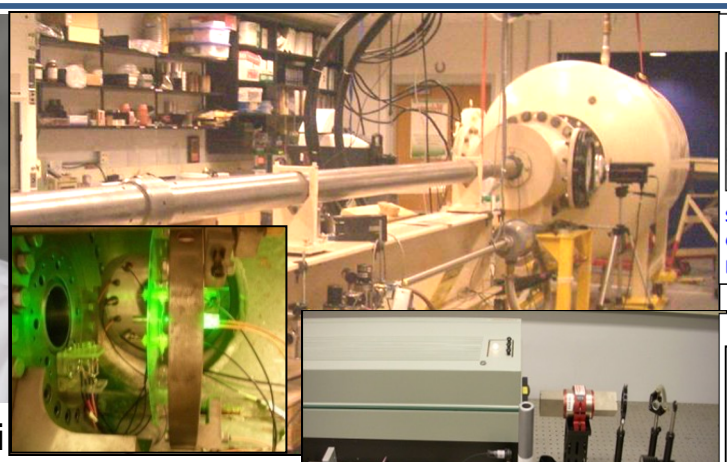


Ultra-hard ceramics (B_4C and SiC) for light-weight armor and ultra-high temperature ceramics (ZrB_2-SiC) for aerospace applications



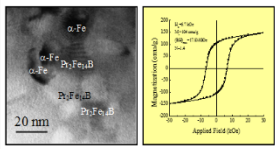
Thermal conductivity and emissivity

Naresh Thadhani



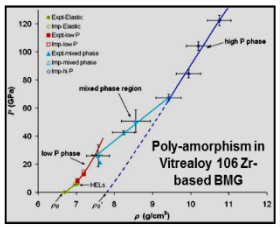
Probing and processing materials under extreme conditions of dynamic high pressure & HSR

MATERIALS PROCESSING



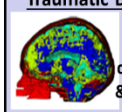
Shock-consolidated (Nd-Fe-B/α-Fe) exchange-coupled nanocomposite permanent magnet (BH_{max}~18MGOe)

PHASE TRANSITIONS



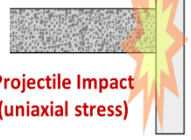
Measurement of change in compressibility provides indication of phase transition in metallic glass

Traumatic Brain Injury



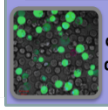
Short and long term diagnostics & modeling

High-pressure Shock-Compression



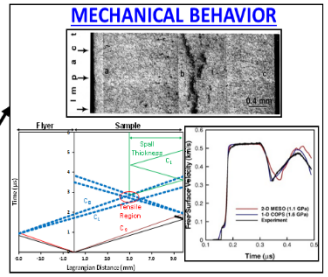
Projectile Impact (uniaxial stress)

Targeted Drug Delivery

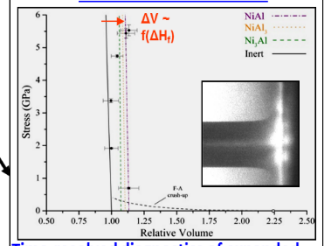


Laser activation of nano-C allows drug permeation in cells

MECHANICAL BEHAVIOR



CHEMICAL REACTIONS



Time-resolved diagnostics of expanded state, wave-speed increase, light emission & strain gradients, reveal shock-initiation

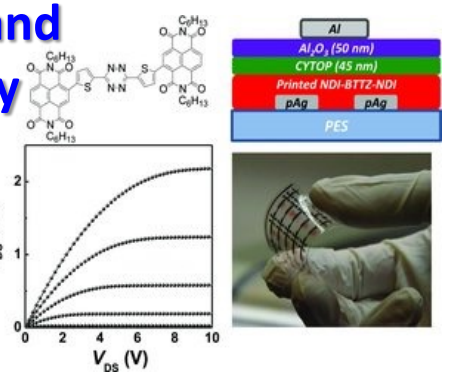
CREATING THE NEXT® *in materials*

Georgia Tech School of Materials Science and Engineering

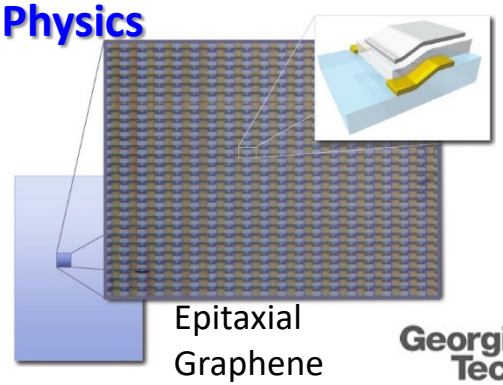
"Materials" Research Across Georgia Tech

Georgia Tech
MOLECULAR & CELL BIOLOGY
COMPUTATIONAL BIOLOGY & BIOINFORMATICS
EVOLUTION, ECOLOGY & BEHAVIOR
BIOLOGY
Integrative & Systems Biology @ Georgia Tech

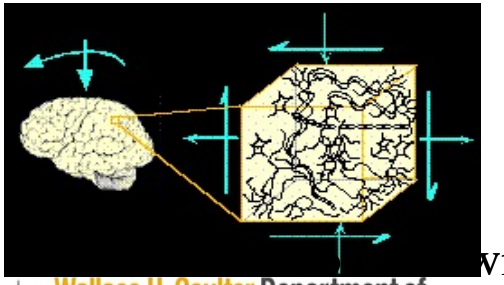
Chemistry and Biochemistry



Physics



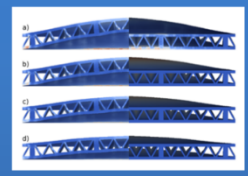
Epitaxial Graphene



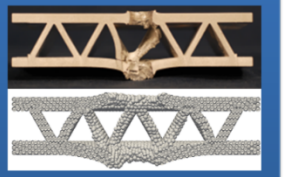
Georgia Tech Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University

EMORY UNIVERSITY

Daniel Guggenheim School of Aerospace Engineering



Sand blasts on corrugated panels

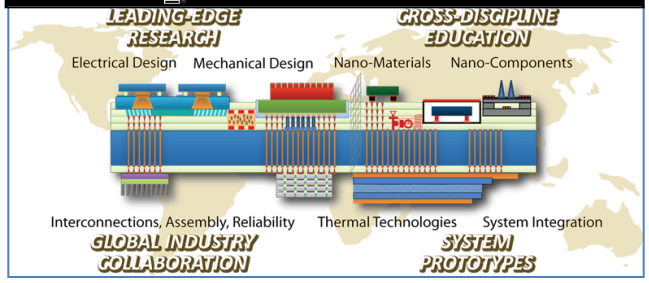


Peridynamics modeling of damage

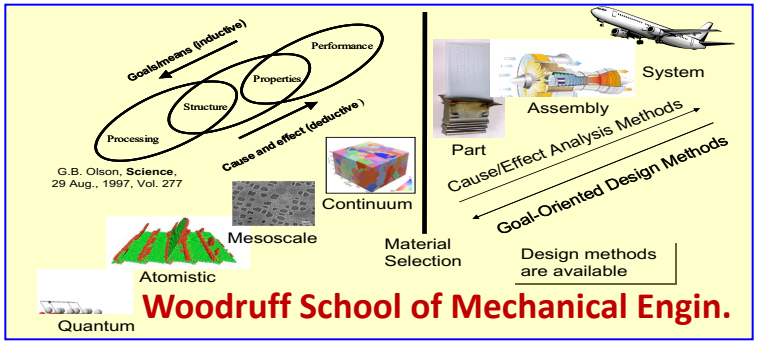
Chemical and Biomolecular Engineering

Materials & Nanotechnology

Georgia Tech School of Electrical and Computer Engineering



Civil and Environmental



Woodruff School of Mechanical Engin.

Georgia Tech Institute for Materials

Georgia Tech STAMI

Georgia Tech Manufacturing Institute

Georgia Tech Strategic Energy Institute

Georgia Tech Renewable Bioproducts Institute

Georgia Tech Research Institute

Georgia Tech Institute for Electronics and Nanotechnology

CREATING THE NEXT® *in materials*

Georgia Tech School of Materials Science and Engineering

Georgia Tech Materials Characterization Facility

Marcus Nanotechnology Building

Marcus Characterization Lab

Loc. in basement of Marcus.

- FEI Nova Nanolab 200 FIB-SEM
- Hitachi HD2700 STEM
- Hitachi HT7700 TEM
- Hitachi SU8230 FE-SEM
- Hysitron T900 Nanoindenter
- Keyence Digital Microscope
- Kratos Axis-Ultra XPS
- Thermo K-Alpha XPS
- Thermo-Nicolet Confocal μ-Raman
- IONToF ToF-SIMS
- Veeco Dimension 3100 AFM
- Zeiss Ultra 60 FE-SEM

Panalytical X-ray Lab

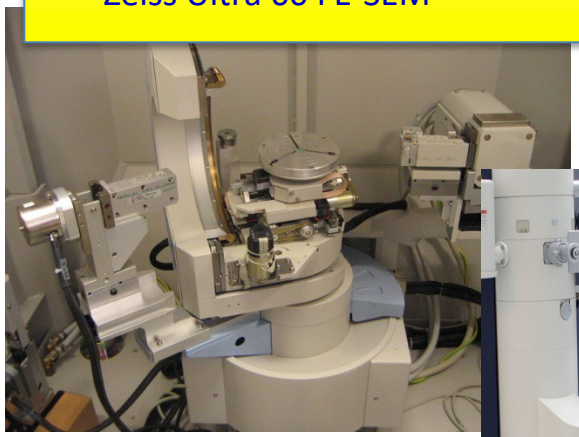
Loc. in basement of Marcus

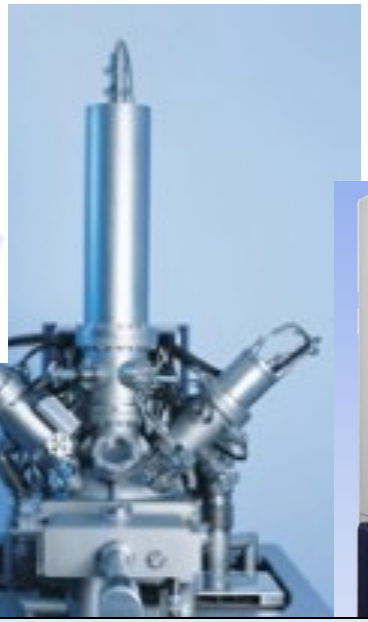
- Empyrean – Multipurpose XRD with SAXS
- X'Pert Alpha-1 MPD
- X'Pert PRO MRD XRD

CNC Electron Microscopy

Located in PTB

- LEO 1530 SEM
- Hitachi SU8010 SEM
- JEOL 100 CX TEM
- Hitachi 2000 TEM
- FEI Tecnai F30 TEM





Hitachi HD2700 STEM

Empyrean Multipurpose XRD

Contact: walter.henderson@ien.gatech.edu

Thank you for visiting