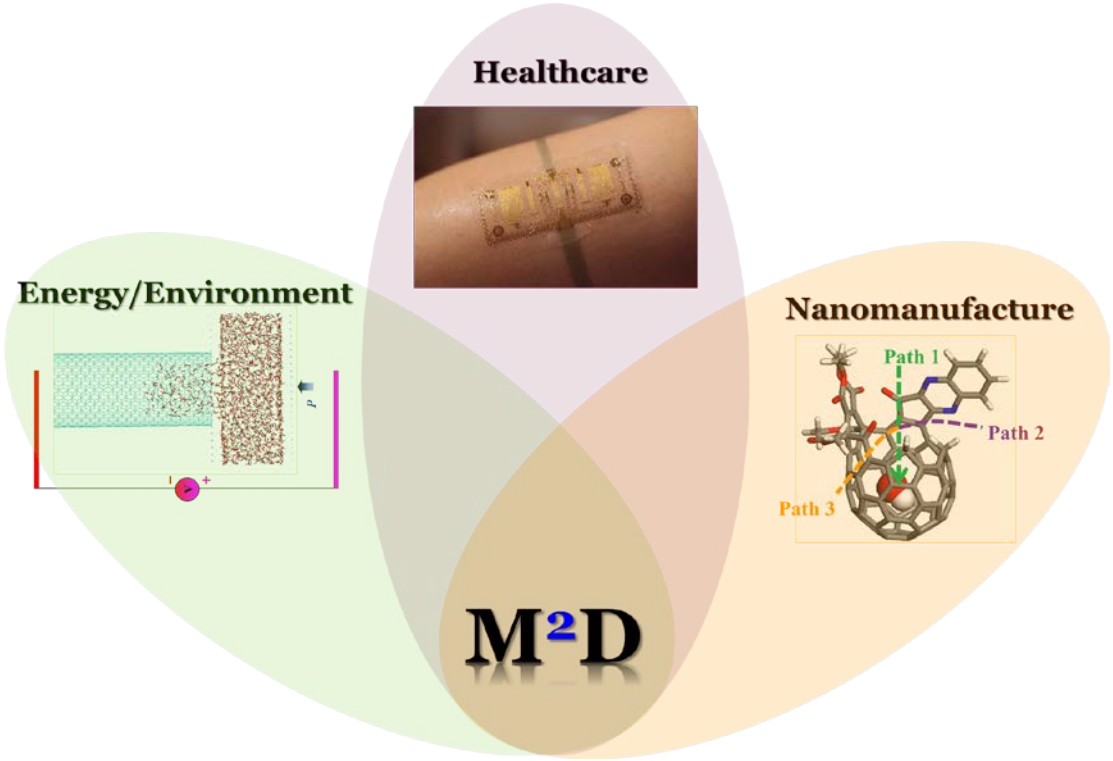
Mechanics for Materials Design (M²D) Group



The urgent demand for energy, environmental sustainability and healthcare represents the world's most paramount challenge for the next 50 years. Meeting this growing need will rely on scientific breakthroughs from the elementary step of materials deformation/manufacturing, energy/mass transfer, and characterization technique at the nanoscale. Our group is exploring mechanics strategies for high-performance, multifunctional, adaptive, and "green" composite materials design down to the nanoscale, through theoretical, experimental, and numerical (CPFEM, MD, DFT, etc.) approaches.

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"Exploring mechanics strategies for materials design down to the nanoscale in energy, environment, healthcare and manufacture"

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Multifunctional Nano/Energy Materials Design

Energy absorption materials (e.g. honeycombs, foams) have been developed for preventing the devices and personnel from impacts, collisions or blast attacks in the last decades. The future prospects for intimate integration of multifunctional energy conversion such as energy absorption, energy capture, energy actuation and energy harvesting is challenging traditional materials and structures. We are addressing such challenges through mechanics design for novel materials and structures at the nanoscale.

Bioinspired Soft Actuation Design

Inspired by nature, advanced materials and structures are required to be smart for sensing surroundings and tuning their properties for survival. We are working on the design of flexible/stretchable soft sensing and actuation structures with self-regulative behaviors in response to external stimuli such as force, temperature, pH value, and light.

Mechanics-Guided Unconventional Nanomanufacture Technique

Growing applications of nanostructures in industry, military and consumable products is challenging the current nanomanufacture technologies, and low-cost, high-efficient and environment-friendly manufacturing solutions are highly demanded. We are interested in the exploration of mechanics-guided unconventional fabrication technique down to the nanoscale such as stress-driven pattern formation, soft materials collapse, and particles assembling in various environments.

Advanced Nanomechanical Characterization Technique

Materials functionality is closely associated with their mechanical properties at the nanoscale, but challenges the conventional mechanical characterization technique. Our aim is to probe mechanical behavior and underpinning mechanism down to the nanoscale by integrating theoretical, experimental and numerical approaches, thereby establishing design rules of material/ structure/function-characterization-modeling paradigm.

RECENT RESEARCH DEVELOPMENTS

- Designed and fabricated multifunctional skin-like devices for simultaneous physiological signals readout and stimulation input with applications in healthcare and human-machine interface.
- Proposed a concept of energy capture for mitigating high impact/blast wave loadings.
- Designed thermal- and electro-nanoactuators.
- Explored low-grade-heat energy harvesting technique
- Developed a universal theory of liquid droplet transport in surface gradient of wettability
- Proposed a mechanics theory of liquid-driven self-assembly of 2D materials into 3D structures from evaporation of its liquid solution

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