Micro/Nano Mechanical Systems Lab – Class#15

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Outline

◆ The rest of the semester
◆ Lin-lab Projects
◆ Near-field Electrospinning
Grading, Quiz & Final Project

Grading:

- 50% Lab reports
- 20% Quiz
- 30% Final Project (presentation 10%, fabrication/testing 10% and written report 10%)

Class Schedule

Selected Papers

Project
Rest of the Semester

3/8 – Other possible MEMS/NEMS labs
3/13 – MD simulation lab (no lecture)
3/15 – project proposal (1-2 pages ppt)
3/20 – 3/22 – MD simulation lab (no lecture)
4/3 – project design/progress (5 pages ppt)
4/5 – review for quiz
4/10 – quiz
4/12 – quiz solution
4/17, 4/19, 4/24, 4/26 – final presentations
Liwei Lin Lab

- **Energy Storage and Power**
  - BPN 742: High Performance & High Energy Density Supercapacitors
  - BPN 782:
  - BPN 672:
  - BPN 885: Transition Metal Surface (TiReS) for Solar Water Splitting

- **Sensor & Sensing Systems**
  - BPN 743:
  - BPN 892:
  - BPN 772:
  - BPN 799:
  - BPN 886:
  - BPN 840: W-Band Additive Vacuum Electronics
  - BPN 855: Flexible Sensors and Actuators
  - BPN 877: Pulse Acquisition and Diagnosis
  - BPN 860: Laser Printed Foldable Electronics

- **Fluidics**
  - BPN 774:
  - BPN 846:
  - BPN 893:

Large Surface Areas, Highly Active Micro/Nano Structures and Materials

Innovations in Design, Materials, Fabrication, and Sensing Mechanism via Micro/Nano Technologies

3D-Printing as a New Manufacturing Tool for \( \mu \)Fluidics
Structural Supercapacitors

BPN 782: Load-bearing Energy Storage Devices

• High strength, light-weight “Functional Structures” for energy storages - sheet metals in airplanes, cars and cell phones...

Carbon Fiber – 7 μm in diameter

[Diagram showing the process of converting carbon fiber into a supercapacitor, including steps like activation, coating of electrolyte, weaving, and the structure of the final product.]

[Graphs showing specific surface area and tensile strength for different samples under various conditions.]
Semi-transparent 3D Supercapacitor

BPN 782: Load-bearing Energy Storage Devices

• Randomly dispersed carbon fibers for semi-transparent foldable 3D supercapacitors

High-strength & good conductivity

Flexible and foldable 3D shapes
High Energy Density & Voltage Range

BPN 742: High Performance & Harsh Environment Supercapacitors

- Vertically aligned carbon nanotubes (VACNT) with uniformly coated TiS$_2$ to extend the working range over 3V

Energy Storage

State-of-art supercapacitors & batteries

CNT+ALD TiN+Sulfurization
AC Gas Sensing by Graphene FET

BPN 772: Room Temperature Graphene Gas Sensors (Late News) Sensor

“From 2D Graphene to 3D Gas Sensing”

- Ultrasensitive
- Small size
- Room Temp.
- Low power
- Selectivity

AC sensing for fast recovery and minimal baseline drift

DC sensing baseline drifts due to strongly adsorbed gases on graphene surface

![Diagram of AC and DC sensing](image)
Highly Responsive PMUTs

BPN 743: Highly Responsive PMUTs (Thursday Oral)

“Bimorph PMUTs for 4X output power and sensitivity”
Unimorph with dual Electrodes

A single-chip gas/liquid flow sensor

A-mode and (left) B-mode (right) scan of the phantom where two layers of PDMS (muscle) and one layer of ecoflex (fat)
Copper based Additive Manufacturing (AM) technologies with innovative electron-beam melting and micro-fluidic electrochemical etching to realize three dimensional vacuum and cooling integrated structures for high frequency vacuum electronics devices (VEDs)
Flexible Actuators for Human Interactions

BPN 855: Flexible Sensors and Actuators

“Piezoelectret-based Flexible Actuator”
Pulse Acquisition and Diagnostics

BPN 877: Pulse Acquisition and Diagnosis

“Traditional Chinese Medicine – Pulse sensor + Big data”

(a) Pressure (mmHg)
(b) Current (nA)
(c) Voltage (V)
(d) AU
(e) AU

Inflate
Deflate
Drift Free
Paper Printed Foldable Electronics

BPN 860: Laser Printed Foldable Electronics

“Laser converted metal carbides as porous electrodes”

“Foldable switch”  “Heavy metal detector”  “Energy Harvester”

Sensor
μFluidics – 3D Printing

BPN 846: 3D Printed Biomedical and Diagnostic Systems

“From 2D soft lithography to 3D printing”

Minimum Inhibitory Concentration (MIC) for Drug Screening

3D Printed Microfluidic Circuitry

Bhattacharjee et al., Lab on a Chip (2016)