School of Dynamic Systems (SDS) Strategic Plan for Research in Nano-Micro-Bio Health Care Systems

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A. GOALS.

Short Term. Improve the modeling, processing, and properties of nanoscale materials. Develop Academic, Corporate, and Clinical Partnerships that will lead to commercialization of the technology.

Mid-Term. Process nanoscale materials into intermediate and derivative materials and use these novel material forms to nano-engineer new biomedical device platforms that have micro-scale features and high performance.

Long Term. Move the prototype biomedical devices into the hands of physicians as quickly as possible to give physicians the capability to do what they need to do to repair the human body and change the outcome for many patients.

B. RESEARCH FOCUS AREAS.

1. Nanoscale Materials, Processes and Devices
   • Synthesis of Low-dimensional nanomaterials (tubes, sheets, wires, particles, thin films)
   • Nanomanufacturing and nanomachining
   • Nanolmprint Lithography
   • Nano metrology
   • Nanoscale modeling and process simulation
   • Mechanics of nanostuctured materials and devices
   • Nanomedicine and bio-nano interface
   • Nanoscale Characterization

(L to R) Carbon nanotube with buckyball; Nano groove; Nanotube with local buckling
2. **Microscale Materials and Processing**
   - Nanotube Ribbon, Yarn
   - Dielectric Functionalization
   - Micromachining and fabrication (including Lithography and others)
   - Multifunctional micromachines
   - Microsystem Design (sensors & actuators)
   - Microforming
   - Micro assembly
   - Micro metrology
   - Microscale modeling and process simulation
   - Biodegradable alloys and composite materials
   - nanocomposite Materials with outstanding mechanical and multi-physical properties
   - Multi-scale Modeling and material design

(L to R) Finite element model of carbon nanotube array; long carbon nanotube array synthesized in UC Nanoworld; carbon nanotube yarn spun at UC Nanoworld

3. **Biomedical Design**
   - Biosensors
   - Micromanipulators
   - Biodegradable material and devices
   - Corrosion Monitoring and Control
   - Nanomaterial-based tissue engineering and drug design
   - Biomechanics of tissues, bones, muscles, and prosthetic implant
   - Modeling hearing impairment and developing new standards
   - Fluid-, Heat-, and Mass Transport in Biological Systems and MEMS Devices
   - Wearable human health monitoring devices

(L to R) Micromanipulator using carbon electronics; micromachined bovine bone
4. **Medical Health Care Systems**
- Cardiovascular Repair
- Cancer Diagnosis and therapy
- Biodegradable Metallic Implants and fittings
- Cell scaffolds using nanofibers and nanotube materials

*(L to R) Magnesium biodegradable screws; biodegradable screws for ACL ligament repair; Biocompatibility of rat mesenchymal stem cells exposed to carbon nanofibers - live cells appear in green while dead cells appear in red*

5. **Environmental and First Responder Health Care Systems**
- Garments for first responders and military personnel
- Electronic textiles, bullet-proof material
- Firefighter nanotechnologies (garments, spray, sensors, antenna)

*Firefighter applications*
C. ACADEMIC, CORPORATE, CLINICAL PARTNERS (Tentative)

- Andrew Schwartz, Lion Apparel
- William Jetter, Fire Chief, Sycamore Township, Ohio EMS
- Joe Sprengard, President, General Nano LLC