School of Chemical & Biomolecular Engineering at Georgia Tech

RESEARCH DEVELOPMENTS

Microneedles and Vaccination

A major area of focus involves the use of microneedle patches to apply vaccines to the skin in a painless, minimally invasive manner. In collaboration with Emory University, the Centers for Disease Control and Prevention and other organizations, ChBE is advancing microneedles from device design and fabrication through pharmaceutical formulation and pre-clinical animal studies through studies in human subjects. In addition to developing a self-administered influenza vaccine using microneedles, we are translating microneedles technology especially to make vaccination in developing countries more effective.

Nanowire Technology

By directing the stacking of atomic layers in silicon nanowires, ChBE is reimagining the properties and uses of the world's most ubiquitous semiconductor. Motivated by the promise of designing materials with entirely programmable atomic arrangements, specifically the extensive property tunability that would accompany it, ChBE researchers recently showed for the first time that the stacking of atoms in a silicon nanowire could be rationally manipulated. This work will find use in fields ranging from electronics and photonics to energy conversion and catalysis.

Paper's Advanced Possibilities

ChBE researchers have created a new type of paper that repels a wide variety of liquids, including water and oil, by modifying the underlying network of cellulose fibers, etching off surface "fluff" and applying a thin chemical coating. The material uses nanometer- and micron-scale structures, plus a surface fluorocarbon, to turn old-fashioned paper into an advanced material. The modified paper could be used as the foundation for a new generation of inexpensive biomedical diagnostics in which liquid samples would flow along patterns printed on the paper using special hydrophobic ink and an ordinary desktop printer, and could also provide an improved packaging material that would be less expensive than other oil- and water-repelling materials, while being both recyclable and sustainable.

Aerosols in the Environment

Located in the School's home, the Ford Environmental Science and Technology Building, the new Georgia Tech Indoor Environmental Chamber Facility is used to investigate aerosol formation and its chemical and physical properties. This state-of-the-art facility consist of two 10 m3 Teflon chambers suspended in a 21' x 12' enclosure surrounded by UV lights and fluorescent sun lamps to achieve a temperature range between 4°C and 40°C. The chamber provides researchers with the ability to perform experiments to understand aerosol formation under a very well-controlled environment over a wide range of parameters, and when combined with field studies, these experiments will provide valuable insights into understanding aerosol formation, composition, and evolution.

Cloud Formation

Based on aerial and ground-based measurements of droplet formation from ten different areas of the northern hemisphere, new research conducted jointly with the School of Earth and Atmospheric Sciences reports that organic coatings on particles don't seem to significantly affect the rate at which cloud droplets form. Scientists originally believed that particles coated in a mixture of combusted petroleum and biomass, or "goop" as it is often referred to, would form droplets at a slower rate than other particles; however, this study suggests differently and provides a small step toward reducing the uncertainity in climate modeling. Researchers hope that they will study particles from other areas of the world in the future.

Cancer Research

We are investigating the role of bone marrow-derived cells (BMDCs) in tumor growth and metastasis. This process is mediated by tumor secretion of proangiogenic chemokines that enter the blood circulation and travel to the bone marrow, where they mobilize BMDCs. By using a variety of techniques, a ChBE research group has found that BMDCs rapidly accumulate in tumors, promoting their growth and metastasis through formation of blood vessels and degradation of extracellular matrix components. Better understanding the migratory process of these cells and their role in the evolution of cancer is critical to developing new detection and treatment methods for the disease.