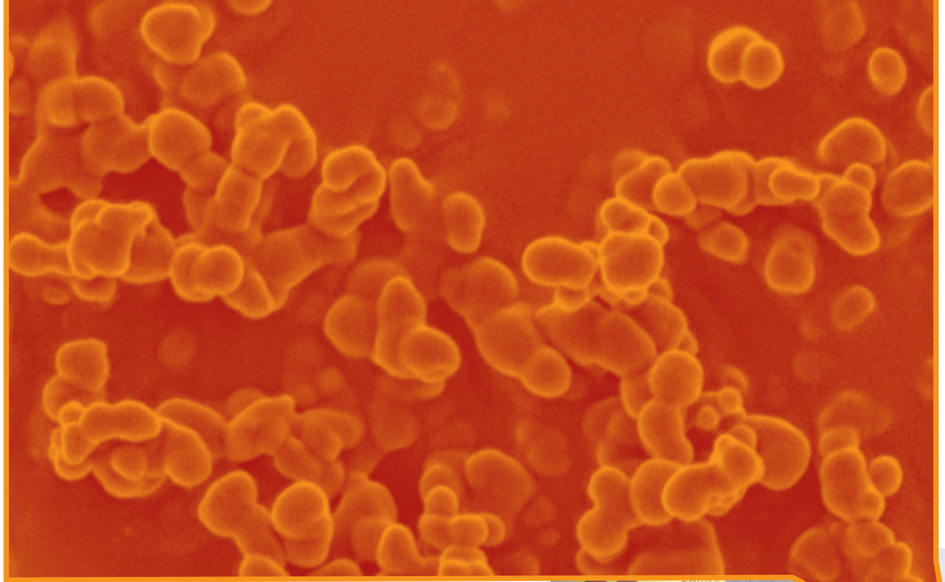

Engineered Particulates

—PIONEERING BIG DEVELOPMENTS ON A VERY SMALL FRONTIER

Professor Rajesh Dave and doctoral student Lauren Beach (an NSF-IGERT Fellow) working at the scanning electron microscope (SEM), a key instrument in research and development efforts involving engineered particulates. The SEM can acquire images such as the one above the photo, showing particles of a pharmaceutical material smaller than 100 nanometers. A nanometer is a billionth of a meter.

MORE EFFECTIVE DRUGS TO COMBAT CANCER AND OTHER DISEASES, SAFER ROCKET FUELS FOR SPACE EXPLORATION, BETTER CATALYSTS FOR REFINING PETROLEUM PRODUCTS SUCH AS GASOLINE.

THESE ARE JUST A FEW APPLICATIONS FOR ENGINEERED PARTICULATES, A FIELD WHERE NJIT IS ENGAGED IN PIONEERING RESEARCH AND DEVELOPMENT. IT'S A BIG COMMITMENT ON A VERY SMALL FRONTIER, INVOLVING POWDERED MICRON- AND NANO-SIZED PARTICLES THAT ARE COMMERCIALLY VITAL BUT VERY DIFFICULT TO HANDLE.

The potential of NJIT's efforts to develop new and improved particulate products is enormous. Such products already generate a trillion dollars annually in the U.S. economy. They are essential for numerous industries: pharmaceuticals, food, energy, ceramics, cosmetics, electronics, optics, specialty chemicals and many more. This technology is also an important part of New Jersey's economy given the diverse industrial operations in the state that require particulate raw materials.

How small is small?

To put the scale of working with engineered particulates in a more familiar perspective, a micron is one millionth of a meter, and it would take some 1000 microns to equal the thickness of a U.S. dime. A nanometer, or a billionth of a meter, is the equivalent of ten hydrogen atoms in a row.

NJIT investigators are looking at various techniques for creating valuable products by engineering specific changes at this scale in the properties of organic and inorganic particles. These include covering the surface of micron-sized particles with sub-micron or nano-sized particles using a dry coating process, synthesizing nano and sub-micron particles, mixing different types of nano-sized particles, and creating nano-structured composites.

Rajesh Dave, distinguished professor of chemical engineering, offers another comparison that conveys a good idea of the scale at which he conducts his research. He says that it would not be atypical to work with particles that are one-half to one-eighth the diameter of a human hair, and to coat those particles with ones that are a thousand times smaller.

Continued after Honor Roll

PHOTO: KAI CHAN

An example from the pharmaceuticals industry illustrates the benefits of manipulating materials on this scale. Many new and extremely potent drugs are manufactured as very small particles, which contributes to their efficacy, or "bioavailability." However, particulate products of this size can quickly become unstable. A solution is to coat the active drug particles with a material that enhances stability. But this presents a formidable manufacturing challenge due to the extremely small size of the particles, their physical surface characteristics and high surface energy.

Innovative coating processes developed at NJIT can meet such production challenges. One patented technique not only facilitates coating to increase drug stability, but can be used for other purposes by the pharmaceutical industry, including the manufacture of more effective time-released medications.

The NJCEP and NSF connections

At NJIT, the New Jersey Center for Engineered Particulates (NJCEP) headed by Dave is a focal point of the university's program in this field, with R&D facilities that are among the most sophisticated in the nation. Other NJIT faculty members who have been instrumental in realizing the center's substantial achievements include Edward Dreizin, Boris Khusid and Robert Pfeffer.

NJIT is also one of the schools in a consortium whose complementary efforts in engineered particulates are being carried out as a National Science Foundation Engineering Research Center (NSF-ERC), an NSF program that recognizes institutions uniquely capable of advancing socially transformative research. In addition to Dave, Khusid and Pfeffer, the NJIT faculty team that energized this initiative included Piero Armenante, John Federici, Zafar Iqbal, Somenath Mitra and Laurent Simon.

Along with NJIT, the members of the consortium are Rutgers University as the lead institution, Purdue University, and the University of Puerto Rico at Mayaguez. They comprise the National Science Foundation Engineering Research Center on Structured Organic Particulate Systems (C-SOPS). It is expected that the 10-year C-SOPS program will receive $100 million in funding from the NSF, industry partners and other sources.

As researchers and educators, C-SOPS participants have four main goals:

- Build a solid scientific foundation for creating structured organic composites
- Develop methodology needed to design, scale, optimize and manage relevant manufacturing processes
- Formulate effective educational and technology-transfer strategies
- Promote participation by underrepresented minorities and women at all levels

The educational dimension

For a technological research university, the diversity of a field that spans as many disciplines and materials as engineered particulates presents a host of educational opportunities. In addition to chemistry and chemical engineering, the field requires expertise in mechanical, electrical, and biomedical engineering, in physics, materials science, computer science and economics.

NJIT students at both the undergraduate and graduate levels are actively partnering with faculty researching engineered particulates. Undergraduate students are also helping to spark an interest in scientific and technological careers among young people of high school age by sharing the excitement of materials science through the university's Pre-College programs.

On the graduate level, PhD candidates at NJIT have benefited from the NSF's Integrative Graduate Education and Research Traineeship (IGERT) grants. This program seeks to train scientists and engineers with interdisciplinary technical knowledge and professional skills vital for success in economically important fields such as engineered particulates.

NJIT has also received NSF funding for the Research Experience for Undergraduates (REU), enabling the launch of a unique educational initiative in the summer of 2006. For ten weeks, undergraduates from NJIT and other U.S. universities, selected on a competitive basis, lived on campus and worked alongside NJIT faculty and graduate students. Their projects involved basic research in engineered particulates and practical application to products as diverse as more effective sun screens and new cancer drugs. REU participants also serve as mentors to young people who have yet to enter college, especially those who come from groups still underrepresented among scientists and engineers. This summer program will continue under the direction of Associate Professor Kwabena Narh.

The tagline of the IGERT program for graduate students is "Transcend Traditional Boundaries." This phrase, though, is applicable to all aspects of the university's activities related to engineered particulates. Working together, NJIT students and faculty are clearly making this happen. They're integrating an exceptional range of knowledge, skills and personal interests to realize the potential of one of the 21st century's most promising technologies. ■

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Learn more about the NJIT Center for Engineered Particulates at www.njit.edu/njcep