Argonne NATIONAL LABORATORY

Darrell H. Reneker

"Nanofibers: Past, Present, Future"

With two radial dimensions, nanofibers have a place in nanoscale materials science and engineering along with particles having 3 nanoscale dimensions and surfaces with 1. Nanofibers of ceramics, semiconductors, metals, and carbon are prepared from polymer nanofibers that contain the necessary elements, by heat treatment in an oxidizing or reducing gas. The invention, development, and use of products engineered at all scales from nanometers upwards, are opening new opportunities.

Electrospun polymer nanofibers have emerged from trade secret uses, mainly in filtration, during the past two decades. As the synthetic polymer industry grew during the past century, economical processes for producing large sheets of polymer nanofibers joined together by solid particles of the same polymer were developed. Dupont's "Tyvek"™ , made from polyethylene, is an example. Gore's "Goretex" ™ depends on short nanofibers of polytetrafluorethylene supported between particles of the same polymer. The textile industry made yarns of nanofibers from blends of polymers that phase separate during the spinning process and create a number of nanofibers of one polymer in a removable matrix of the other polymer.

Progress was stimulated by the easy manufacture nanofibers in a laboratory or on a continuous process line using economical equipment. New kinds of nanoscale electronic devices that control energy flow, or information flow, for wearing apparel with fantastic properties are imagined. Nanofibers as supports for enzymes or other catalyst particles are being developed. Wound dressings, activated by moisture, help intractable wounds to heal. Research on living cells, supported on or in, and interacting with nanofibers, is opening new biomedical vistas. Atoms in molecules in nanofibers and on graphene sheets are observed in high resolution electron microscopes. Artificial dielectrics with unusual optical properties are being made. Solar sails, made of nanofibers, in space, can transport cargo between planets. Promise, imagination, synergism and reality have come together and are producing exponential growth in the materials science and engineering of nanofibers.

Darrell H. Reneker is Distinguished Professor of Polymer Science at the University of Akron. He holds a B.Sc. degree in electrical engineering from Iowa State University, and a Ph.D. Degree in physics from the University of Chicago. His thesis research was on the interaction of electrons and sound waves in bismuth at liquid helium temperatures. He began research on polymer single crystals at DuPont in 1959, using electron microscopy to observe morphological features of the newly discovered folded chain lamellar crystals. His pioneering studies of dispirations, which are crystallographic defects in the helical symmetry of polymer crystals that enable a polymer chain to diffuse along its axis, through an otherwise perfect crystal. This work led to the discovery of a family of related defects in polymer crystals, which can translate and rotate polymer molecules by moving along the chain. At the National Institute of Standards and Technology (NIST), he continued research on dispirations, and became Acting Director of the Center for Materials Science, one of the four major organizational units of NIST. He received the Silver Medal Award from the U.S. Department of Commerce for outstanding research. He was a charter member of the Senior Executive Service, and received a superior service bonus. He also served as Executive Secretary of the Committee on Materials of the White House Science Office for 4 years. In 1989, Reneker became Professor of Polymer Science and Director of the Institute of Polymer Science at the University of Akron, where he began research on electrospinning and polymer nanofibers. In a few years, a fast moving front of materials research in the area of electrospinning and nanofibers was identified by Thomson ISI. One of Reneker's papers, co-authored with Alexander Yarin, was identified as the "frequently cited paper" in this fast growing area of research. Several of his patents are licensed to industry, and he has contributed to the founding of two companies that manufacture nanofibers.

Wednesday, January 7, 2012 | 3:00 p.m.

APS Colloquium

Bldg. 402 | APS Auditorium
Argonne National Laboratory