A. Paul Alivisatos to receive 2011 Von Hippel Award for colloidal nanoparticles

The 2011 Von Hippel Award, the Material Research Society's highest honor, will be presented to A. Paul Alivisatos, director of the Lawrence Berkeley National Laboratory and Larry and Diane Bock Professor of Nanotechnology, University of California–Berkeley. Alivisatos is being recognized for "the development of the fundamental scientific basis for growing and utilizing defect-free colloidal semiconductor nanoparticles, providing the basis for biological imaging, solid-state lighting, and the capture and conversion of solar energy to electricity." Alivisatos will accept the honor during the awards ceremony at the 2011 MRS Fall Meeting in Boston.

One of the most important building blocks of nanoscience is the colloidal nanocrystal. High-quality, defect-free colloidal inorganic nanoparticles of controlled size and shape are now made routinely by thousands of research groups around the world, and their size-dependent properties are widely studied. A few key foundational studies by Alivisatos and co-workers provided an understanding of the underlying principles and scaling laws needed for this class of material to be developed.

Alivisatos has mapped out the size-dependent melting of quantum dot semiconductor materials, showing how it is possible to anneal out defects, and to eject impurities from a growing colloidal nanoparticle formed at just a few hundred degrees C, well below the temperatures needed to form high-quality epitaxial two-dimensional films. Alivisatos also showed that size control depends upon careful separation of nucleation and growth, as well as the time scales involved, and upon the concept of "size distribution focusing," in which the distribution of nanoparticle sizes is narrowed when small particles grow faster than large ones. Proof of the high quality of nanocrystals is gleaned from studies of optical properties, as well as from studies of the structural transformations of nanoparticles under high pressure, demonstrating the absence of defects. The synthesis of high-quality colloidal nanocrystals rests upon key work by Alivisatos, and is an essential component of the development of colloidal quantum dots and other nanocrystals.

Colloidal quantum dots are the size of a protein molecule, and when appropriately functionalized, can be introduced inside cells and tissues as biological labels. They are used currently in fluorescent imaging in biology because they do not bleach and they yield a family of solid-state materials with a wide range of emission colors and superior luminescence characteristics, yet they can be processed in solution to make them biocompatible. Alivisatos founded Quantum Dot Corporation, which makes colloidal quantum dots commercially available to researchers.

In 1994, Alivisatos and co-workers demonstrated the first light-emitting diodes made with colloidal quantum dots, the basis of some early quantum dot solid-state lighting products with low manufacturing cost, high color purity, and low energy consumption. Similarly, colloidal quantum dots are under investigation in a range of solar cell designs developed by Alivisatos and co-workers—the low cost and high volume processing of these quantum dots may enable new types of solar photovoltaic and solar fuel generators.

In the last decade, Alivisatos has demonstrated the emergence of "artificial molecules," where small numbers of colloidal nanoparticles are joined together into specific "molecular" arrangements with controlled symmetry and connectivity. These new "molecular" systems have opened a new area of materials for discovery and innovation.

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An important breakthrough by Alivisatos in this area has been the demonstration of the "plasmon ruler," which, for example, can measure the distance between two Au nanocrystals joined by DNA or peptides to measure dynamical distance changes in biological systems.

Another important area Alivisatos has pioneered is the study of chemical transformations of colloidal nanocrystals. He has also demonstrated methods for making branched nanocrystals, discovered the nanoscale Kirkendall effect, a general approach for making hollow nanoparticles, and has developed concepts of ion exchange in nanocrystals as a means of separately controlling the composition, size, and shape of a colloidal nanocrystal system.

Alivisatos received a Bachelor's degree from the University of Chicago in 1981, and a PhD degree in physical chemistry from the University of California–Berkeley in 1986. He was a postdoctoral fellow at AT&T Bell Labs (1986–1988). He joined the University of California–Berkeley as a faculty member in 1988. He became director of the Lawrence Berkeley National Laboratory in 2009.

Alivisatos has over 220 publications and over 15 patents. He is the scientific founder of Quantum Dot Corp.; Nanosys, Inc.; and Solexant, Inc. and founding editor of *Nano Letters*.

His honors include the Alfred P. Sloan Foundation Fellowship; the ACS Exxon Solid State Chemistry Fellowship; the Coblentz Award; the Wilson Prize at Harvard; the Materials Research Society Outstanding Young Investigator Award; the ACS Award in Colloid and Surface Chemistry; the Rank Prize; the

Eni Italgas Prize for Energy and Environment; the Ernest Orlando Lawrence Award; and the Kavli Distinguished Lectureship in Nanoscience, MRS. He is a fellow of both the American Physical Society and the American Association for the Advancement of Science. In 2004, he was elected into the National Academy of Sciences and the American Academy of Arts and Sciences.

The MRS Von Hippel Award includes a $10,000 cash prize, honorary membership in MRS, and a unique trophy—a mounted ruby laser crystal, symbolizing the many faceted nature of materials research. The award recognizes those qualities most prized by materials scientists and engineers—brilliance and originality of intellect, combined with vision that transcends the boundaries of conventional disciplines, as exemplified by the life of Arthur von Hippel (http://vonhippel.mrs.org).

Phaedon Avouris selected for 2011 David Turnbull Lectureship

The Materials Research Society's David Turnbull Lectureship recognizes the career of a scientist who has made outstanding contributions to understanding materials phenomena and properties through research, writing, and lecturing, as exemplified by the late David Turnbull of Harvard University. This year Phaedon Avouris of IBM's T.J. Watson Research Center in Yorktown Heights, New York, has been selected to give the 2011 Turnbull Lecture. Avouris is cited "for his development of nanoscience and nanotechnology, in particular for carbon nanotubes, graphene and semiconductor surfaces, through imaging and measurement of their electronic structure and electrical properties; their chemical and physical modification by scanning probe techniques; and their incorporation into advanced electronic and photonic devices." Avouris will be presented with the award at the 2011 MRS Fall Meeting in Boston.

Avouris's research work spans a broad spectrum and has had a profound impact on our understanding of the physics, chemistry, and applications of nanoscale materials—to such an extent that he can be considered as a founder of the fields of nanoscience and nanotechnology.

Avouris's early nanoscience work focused on the physical chemistry of the surfaces of solids with adsorbed atoms and molecules, using high-resolution electron energy-loss spectroscopy. With the development of the scanning tunneling microscope (STM), Avouris realized its potential for performing electron spectroscopy with atomic resolution. He made the first observations of local changes in the electronic structure of a Si surface upon chemical bond formation, and published early studies of surface chemical reactions, electron standing waves on surfaces, and STM tip-induced reactions.

Avouris's recent work has focused on carbon nanotubes (CNTs) and graphene for electronics and photonics applications. He is a leader in the field of carbon electronics, developing an early CNT field-effect transistor (FET), demonstrating the potential of CNTs to outperform silicon transistors, building the first logic gate using a single CNT and introducing charge-transfer doping. Avouris pioneered experiments on transport mechanisms in CNTs and developed techniques for separating CNTs of differing electrical properties. His demonstration of ambipolar transport in CNTs has had tremendous impact, and his team's ring oscillator built on a single CNT is still the most complex functional molecular device achieved. Avouris has led the development of CNT optoelectronics, raising hopes for a unified electronic and optoelectronic technology based on one material. In graphene, Avouris and his team fabricated nanoribbon FETs and demonstrated GHz operation, achieved record performance in graphene RF transistors on SiC, and produced the first photodetector operating from the infrared to the ultraviolet.

In addition to his research contributions to nanoscience (over 400 publications and 25,000 citations), Avouris has contributed to the development of the field of nanoscience in other ways. He organized an early conference on nanotechnology in 1992, sponsored by NATO and the Engineering Foundation, and edited one of the first books on nanoscience, *Atomic and Nanometer Scale Modification of Materials* (Plenum, 1993). He co-organized the first conference on "Atomic Level Electronics" (Adriatico Research Conference), the first Engineering Foundation Conference on "Nano- and Molecular Electronics," the first U.S. National Academy Conference on Nanoscience, and numerous symposia on nanoscience and nanotechnology for various professional conferences. He was a founding member of the Nanometer Scale Science and Nanotechnology division of the American Vacuum Society. He served on the advisory editorial boards of numerous journals devoted to nanoscience and technology and is an editor of the Springer book series on nanoscience. Avouris has published articles explaining nanoscience and nanotechnology in *MRS Bulletin, IEEE*