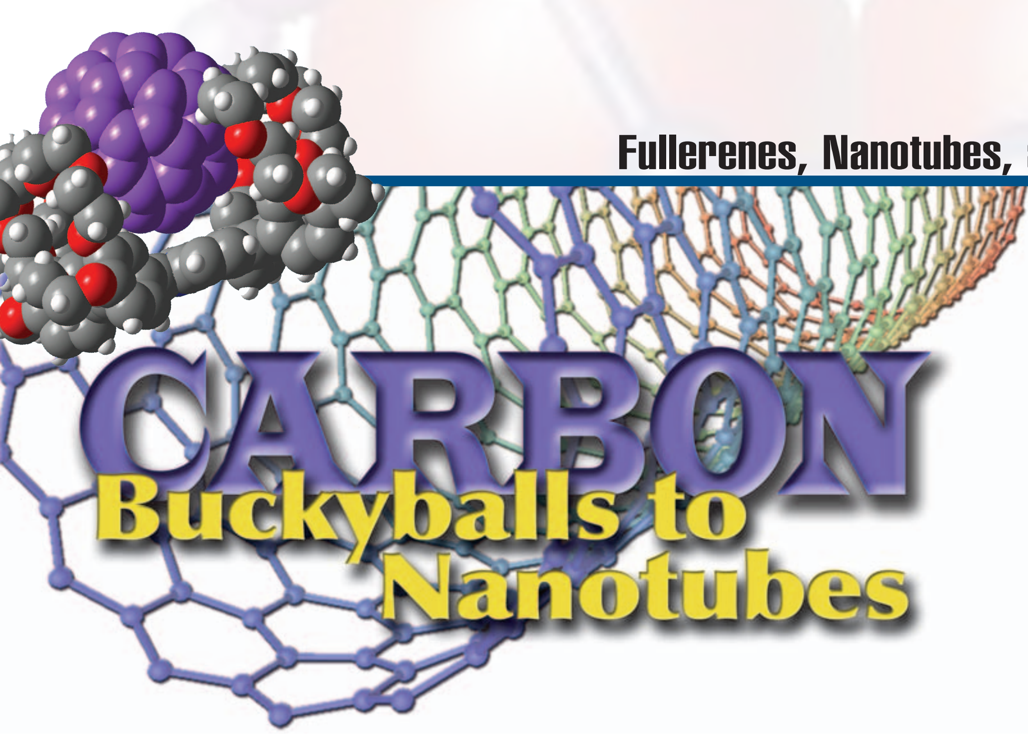

CARBON Buckyballs to Nanotubes

by Francis D'Souza

The feature articles in this issue of *Interface* focus on the research and development of carbon-based fullerene and carbon nanostructures. Carbon is a versatile element and can form various allotropes, including graphite, diamond, and fullerene-like structures. The most significant spin-off product of fullerene research, leading to the discovery of the C_{60} "buckyball" by the 1996 Nobel Prize laureates Robert F. Curl, Harold W. Kroto, and Richard E. Smalley, are nanotubes based on carbon or other elements. When a single sheet of graphite honeycomb is rolled, it is possible to produce a variety of carbon cylinders termed as carbon nanotubes. The extreme properties of fullerenes and carbon nanotubes, such as outstanding mechanical, thermal, electronic, and electrical properties, coupled with chemical robustness, have spurred a broad range of applications. Being only a few nanometers in diameter and a millimeter long, the high length-to-width aspect ratio of nanotubes has provided truly unprecedented molecules for macroscopic devices of this size. This area of research has seen a strong support both from government and industrial sources during the recent years.

Research on fullerenes, nanotubes, and carbon nanostructures often encompasses many fields outside the traditional scope of ECS: organic functionalization of fullerenes and carbon nanotubes, the chemistry of endohedral fullerenes, and biochemical and biomedical applications of fullerene and carbon nanotubes, to name a few. Hence, constant effort is needed to bring these areas of research into the ECS framework for scientific discussion and presentation.

This issue of *Interface* includes four feature articles, which highlight these growing areas in fullerene and carbon nanotube R&D. Research on fullerenes is now a mature subject. Martin *et al.* describe recent progress in the syntheses and applications of molecular and supramolecular fullerenes. As discussed in this article, the convex surface of fullerenes affords new possibilities for the study of new reactions and mechanisms under severe geometrical constraints. The design of C_{60}-based photosynthetic mimics for generating long-lived charge separated states efficiently has been one an important research endeavor. Thus the article of Fukuzumi, Kamat, and co-worker highlights the design of efficient, low-cost organic solar cells based on fullerenes. The supramolecular chemistry approach as a means of assembling donors (porphyrin) and acceptors (C_{60}) for light energy conversion has been extensively studied. Organized supramolecular assemblies of multi-porphyrin arrays with fullerene molecules in a three-dimensional network provide ideal systems for fulfilling enhanced light-harvesting efficiency of chromophores over a wide range of the solar spectrum. Composites of donor and acceptor moieties in the form of clusters when assembled as a three-dimensional network on a conducting surface are shown to provide a means for achieving efficient photocurrent generation. Semiconductor nanoparticles and carbon nanotubes are also shown to serve as a support for organizing supramolecular assemblies and to facilitate light energy conversion.

Recent progress in the area of endohedral fullerenes is discussed by Dunsch and Yang. The recent breakthrough on the high-yield production of nitride cluster fullerenes has advanced this area of research. Among the physical properties of endohedral fullerenes, magnetic properties have not been largely explored in terms of their potential applications. The successful synthesis of peapods, *i.e.*, nanotubes encapsulating fullerene molecules inside the core, has initiated another branch of metallofullerene research. The energy bandgap modulation in peapods is expected to generate conceptually new molecular devices, with different functionalities compared to empty single-walled nanotube (SWNT) electronic devices. The change of conduction properties of SWNTs upon metallofullerene filling studied for $(Dy@C_{82})_m@SWNTs$ has revealed the modulation of the electronic structure by the insertion of $Dy@C_{82}$ molecules and allowing the fabrication of novel transistors and rectifiers. Weisman and Subramoney highlight the advances in the R&D of SWNTs. SWNTs are prototypical quasi-one-dimensional quantum wires composed of a single element (carbon), with walls only one atom thick and tens of atoms in circumference. Their article discusses the electronic and optical properties of SWNTs and related potential applications.

Fullerenes and carbon nanostructures have already shown a wide range of unique physical and chemical properties that make them attractive for the synthesis of new advanced materials. Applications encompass a wide spectrum of technologies and many developments rely on new materials and our ability to understand their properties. More research in this area is clearly needed to fully explore the possibilities offered by these materials, for example, in nanoscience, biosensors, and photovoltaics. As the field is rapidly changing, the newly formed Fullerenes, Nanotubes, and Carbon Nanostructures Division is eager to be as inclusive as possible and to broaden our perspectives. On behalf of the Fullerenes, Nanotubes, and Carbon Nanostructures Division, we hope that *Interface* readers enjoy the feature articles and the related article in "The Chalkboard" column. ■

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