Calixarene Separates C_{60} from Other Fullerenes

In the April issue of *Chemistry Letters* (published by the Chemical Society of Japan), researcher Seiji Shinkai reported that the C_{60} fullerene can be separated from other fullerenes in a carbon-powder soot by using calixarene. This method produces a one-to-one complex of C_{60} and calix[8]arene. When C_{60} enters the cavity of calix[8]arene, it disrupts the intermolecular hydrogen bonding of the OH groups, causing the host to suddenly change from soluble to insoluble in a solvent like toluene. By collecting the precipitated C_{60}•calix[8]arene complex and then putting it into chloroform, which has an even higher affinity to the host, the chloroform replaces the C_{60}, which is precipitated in 70% yield and 99.8% purity. Compared to the standard chromatography method of separation, this new method reduces separation costs by a factor of 50 or so.

Shinkai, a member of the Department of Organic Synthesis, Faculty of Engineering, Kyushu University, carried out the research as a part of his Chemireconics Project under the ERATO program. This project is exploring the basic relationships between the molecular structures of hosts (calixarene and other intelligent compounds) and their recognition properties. Through modifications, an attempt is also being made to design "artificial" recognition systems with very high recognition of and selectivity toward alkaline and rare-earth metal ions and organic molecules. Efforts are not being limited to particular hosts, like those found in nature, but include entirely new recognition mechanisms and recognition targets, while also aiming to control (switch) the activity of the receptors.

This study of calixarenes and other compounds aims to establish a high-precision chemirecognition system by introducing into these compounds (1) an interface for binding with a specific guest atom or molecule, (2) a transducer for the information transduction, and (3) a stimulation receptor for on-off control of the interface and transducer. Theoretical computer calculations are being made to support the design of such recognition systems. By establishing methodologies for designing recognition, superior molecular sensors and artificial enzymes with high selectivity, environmental resistance, and utility may be produced, all in artificial systems.

In addition to the work on buckyballs, Shinkai will report in a future issue of *Chemistry Letters* (May or June) that modification of calixarene allows an extraordinary jump in selectivity (from about 10^3 to 10^6) of Na with respect to K. The method successfully reverses a clever method of nature. Since the only way to discriminate between physically similar alkaline metals is by size, in nature the antibiotic valinomycin can selectively detect Na even in the presence of K by using a bigger ionophore which is also large enough to include Rb. Though the affinity to K is slightly reduced, the affinity toward Na is only slightly decreased, but the selectivity is greatly increased. Thus, by designing a very small cavity at the "interface"—with a size between that of Li and Na—using calixarene capped with a 4-oxygen crownether-type loop, a cavity with a very

https://doi.org/10.1557/S0883769400036472 Published online by Cambridge University Press

large affinity toward Na was obtained.

Other than calixarenes, cholesterol and boronic-acid moieties could be used as platforms of "intelligent" recognition. Since cholesterol forms a helical structure, the stability and related aggregation structure could be controlled by introducing certain substitutes and changing the C-3 position. It was also found that the cholesterol boronic-acid derivative can be applied to the recognition and optical resolution of saccharides (sugars). A saccharide and a cholesterol boronic acid compound form a 1:2 complex with a different steric structure, depending on the type of saccharide. Adding such a complex to a cholesteric liquid crystal affects the helical structure of the liquid crystal as a "transducer," producing a different color change depending on the type of saccharide of the complex.

F.S. Myers

Coating Adherence Theory Relies Partly on Diffusion

Theories which assume that the molecular attraction between sticking particles and a surface makes a coating stick or become unstuck have proved incorrect in predicting coating rates, says Steve Granick, professor of materials science and engineering at the University of Illinois.

Granick and his team have been able to provide evidence that coating rates are explained better by knowing how the components of a coating compete with one another to adhere. "Molecules unsticking from a surface must find a path through the other still-stuck molecules into the medium of air, water, or other surrounding fluids," he says.

In an article in the December 24, 1993, issue of *Science*, Granick, graduate student Harry Johnson, and co-investigator Jack F. Douglas of the National Institute of Standards and Technology (Gaithersburg, Maryland) state that formulas based on the new theory show a better correspondence between theory and reality than do those based on older methods.

While older theories describe unsticking as a process based on exponential equations similar to those used to describe radioactive decay rates, the new theory describes unsticking by relying in part on diffusion. Unsticking may be caused by separation, bubbling, deterioration, or cleansing. Diffusion not only considers the probability that molecules will find paths to leave a surface, but also accurately represents the slowness of the reactions between a sticking agent and a surface.

The mathematics developed by Douglas takes diffusion into account and uses experimental results recorded by Granick to predict a slower, more accurate rate for polymers to stick or become unstuck from a surface. Using the new formulas, scientists can, for example, predict with greater accuracy how many molecules of certain polymers will leave the surface of certain other polymers in a given time period.

The theory opens fields of investigation in water purification, chromatography, the cleaning of biomaterial implants, and the development of composite materials used to make better cars and space shuttle nose cones.

CSAC Elects New Chairman

Alan Lauder has been elected to a two-year term as chairman of the Council on Superconductivity for American Competitiveness (CSAC) by its board of directors. Previously CSAC vice chairman, Lauder succeeds Richard P. Hora, who is with General Dynamics Corp. In accepting the CSAC chairmanship, Lauder singled out Hora's completion of the *Worldwide Market Forecast for Superconductivity* as an example of the contributions Hora has made to CSAC. Lauder is general manager for superconductivity at DuPont's Corporate New Business Development Division, where he leads an industrial high-temperature superconductor program in electronic applications.

Gregory J. Yurek, elected CSAC vice chairman, is president and chief executive officer of American Superconductor Corp.

The CSAC board identified several objectives for the association in 1994, focusing on electronics and energy applications of superconductors as the two principal applications with the most immediate commercial impact. The board also agreed the superconductor industry must provide input to the White House National Science and Technology Council in its stated effort to improve strategic coordination of R&D programs and to conduct a government-wide review of R&D spending priorities.

The board identified the following key near- term objectives:

- continuing to develop an industry-led proposal for a superconducting satellite/telecommunications demonstration project,
- advocating an increase in support for the Superconductivity Partnership Initiative at the Department of Energy,
- continuing support for programs such as the Advanced Technology Program for civilian industries and the Technology Reinvestment Project for defense conversion, and
- continuing CSAC's participation in the International Superconductivity Industry Summit process with Japan and Europe.

https://doi.org/10.1557/S0883769400036472 Published online by Cambridge University Press

Alexander von Humboldt Foundation Marks 40 Years

The Alexander von Humboldt Foundation, a German educational benefactor, is observing 40 years of achievement. Presenting the 40th Annual Report in Bonn, foundation president Reimar Lüst said an unusually high number of former Humboldt scholarship winners have gone on to assume high-ranking positions in industry and politics in their native countries. Lüst also expressed confidence that Germany's foreign and scientific-aid policy makers will come to realize and appreciate the foundation's work as the demand for Humboldt scholarships abroad now reaches record levels.

The foundation has sponsored 15,152 foreign scientists through scholarships and prize awards, and approved research grants to 933 German scientists. Substantial funding has also been provided to scientists for research cooperation projects and for setting up small programs to promote young artists and future technical and managerial personnel. Sixty-four percent of the scholars have been from the natural sciences, 26% from human sciences, and 10% from engineering. Eighty-one percent of the research students and 70% of the research prize recipients attended a German university or college, the remainder going to non-university research institutes, primarily the Max-Planck-Institute.

Humboldt scholars often spend years in Germany completing their studies, and are encouraged to maintain links through a series of foundation initiatives and a comprehensive contact network.

All candidates are accepted on the basis of a stringent selection procedure, regardless of subject or nationality quotas, gender, race, religion, and politics. Funding is open to scientists of all disciplines and nations. So far, more than 120 different nationalities have been represented.

Most research scholars and award recipients have come from India, Japan, the Peoples Republic of China, Poland, and the United States. Ten percent of the sponsored scientists were women. Program participants averaged two publications during their academic stays, for a total of about 31,000 in 40 years. Some 4,000 of these were translated into 38 languages, without Humboldt funding.

All German host universities and institutes were selected by the Humboldt Foundation. The foundation's general secretary for the past 37 years, Heinrich Pfeiffer, reported that leading institutes were the Universities of Munich, Bonn, Heidelberg, Freiburg, Cologne, and Göttingen.

Over its 40 years, the foundation has received public funds amounting to 1 billion DM, 69% from the Foreign Ministry, 18% from the Federal Ministry of Research and Technology, and 4% each from the Federal Ministries for Education and Science, for Economic Cooperation, and for Development. Sixty-three million DM in private funding came primarily from the Alfried Krupp von Bohlen and Halbach Foundation, the Association of Foundations for German Science, the Fritz Thyssen Foundation, and the Volkswagen Foundation.

Lasers Used to Make Multimetal Met-Car Molecules

A research team at Pennsylvania State University reports it has succeeded in incorporating more than one type of metal into the structure of the metal-and-carbon "met-car" molecules discovered in 1992.

https://doi.org/10.1557/S0883769400036472 Published online by Cambridge University Press

Led by A.W. Castleman Jr., Evan Pugh Professor of Chemistry, the team believe themselves to be the first to accomplish this and have reported their work in the April 1 *Journal of Chemical Physics*.

To make the multimetal met-cars, the researchers focused an intense beam of laser light onto a crucible containing a mixture of metal carbide powders. On analyzing the vaporized powders, they found they could produce a variety of the carbon-based met-cars, some containing both titanium and zirconium metals and others containing both titanium and hafnium. The straightforward nature of the technique is a considerable improvement over the more complicated experiments done since met-car molecules were discovered in Castleman's lab in 1992.

"We are not yet sure to what extent we can put together combinations of all the transition metals," Castleman says, "but it appears that we will be able to tailor the electronic characteristics of these molecules by selectively incorporating a variety of metals into their structures."

Castleman believes the multimetal met-cars have the potential for being good catalysts and, on a more fundamental level, could give scientists a tool for testing theories about why some of these hollow cage-like molecules are so stable, while others are not.

The team continues work on the project, studying the subtleties of the optical absorption characteristics of the met-cars and looking across the Periodic Table to choose the right combination of elements for testing the theories.

1995–96 Fulbright Competition is Open

The Fulbright Scholar Program has opened its 1995–1996 competition. Fulbright opportunities for university lecturing or advanced research in nearly 140 countries are open to professionals, independent scholars, and artists both within and outside academia. Scientists, applied professionals in technical fields, individuals in the private sector and government, and many others participate regularly, says Steven A. Blodgett of the Council for International Exchange of Scholars.

The Fulbright Program is funded and administered by the U.S. Information Agency. Financial support is also provided by participating governments and by host institutions in the United States and abroad.

Awards range from two months to a full academic year, and many assignments are flexible to the needs of the grantee. Basic eligibility requirements for a Fulbright Scholar award include U.S. citizenship and

https://doi.org/10.1557/S0883769400036472 Published online by Cambridge University Press

a PhD degree or comparable professional qualifications for certain fields. Teaching experience is expected of applicants for lecturing awards. Language skills are needed for some countries, but most lecturing assignments are in English.

The deadline for applications for research or lecturing grants to all world areas is **August 1, 1994**. For information and application materials, contact the Council for International Exchange of Scholars, 3007 Tilden Street NW, Suite 5M, Box GNEWS, Washington DC 20008-3009. Phone (202) 686-7877; fax (202) 362-3442. Bitnet (for application requests only) is CIES1@GWUVM.GWU.EDU.

MRS Members Among New APS Fellows

The following members of the Materials Research Society are newly elected Fellows of the American Physical Society:

■ **Division of Condensed Matter Physics**

Alfonso Baldereschi - for his fundamental contributions to the theory of electronic states in solids, and in particular for the development of widely used methods for the calculation of the electronic structure.

Ross D. Bringans - for pioneering work in the application of angle-resolved photoemission spectroscopy to semiconductor surfaces.

Roy G. Goodrich - for pioneering studies of the Fermi surface properties of metals and of low-temperature excitations in novel superconducting materials.

Laura H. Greene - for work on the physics of novel materials, in particular physical properties of high-temperature superconductors and artificially layered thin-film structures.

Arthur F. Hebard - for experimental studies of two-dimensional superconductors and for the discovery of superconductivity in the fullerenes.

Lia Krusin-Elbaum - for fundamental work on the magnetic properties of high-temperature superconductors.

Serge Luryi - for theory of electron transport in low-dimensional systems and invention of novel electron devices.

Clifford G. Olson - for high-resolution angle-resolved photoemission measurements on high-temperature superconductors.

Clive H. Perry - for sustained contributions to the fields of far-infrared, Raman and inelastic neutron scattering spectroscopy of ferroelectrics, magnetic materials, and semiconductors.

Lynn F. Schneemeyer - for critical contributions to the understanding of collective phenomena in sliding charge density wave compounds and of high-temperature superconductivity by the growth and characterization of single crystals.

David A. Weitz - for the study of novel classical physics in complex systems, emphasizing aggregation and light scattering of colloids, dynamics in multiply-scattering media, and enhanced optical scattering from surface adsorbates. Weitz is the Guest Editor of this issue of the *MRS Bulletin*.

■ **Division of High Polymer Physics**

Anna C. Balazs - for innovative application of theoretical methods to describe and predict the effect of sequence distribution on the miscibility of polymer containing mixtures and their adsorption onto surfaces and interfaces.

Gerald G. Fuller - for significant contributions in optical rheology to elucidate the characteristics of polymer melts and solutions during flow.

Georges Hadziioannou - for pioneering scattering studies on the bulk structure of block copolymers and on the behavior of block copolymers at surfaces.

Timothy P. Lodge - for incisive experimental work in polymer solution dynamics, particularly in the study of polymer-solvent interactions and on the mechanisms of diffusion.

■ **Division of Materials Physics**

Michael J. Aziz - for unique experimental and theoretical contributions to our understanding of the kinetics of crystal growth in covalent systems and of solute trapping in rapid solidification processing.

Didier de Fontaine - for continuing theoretical contributions to our understanding of the thermodynamics, phase stability, and electronic structure of metallic alloys and ceramic superconductors, and for pioneering work on phase diagrams.

Noble M. Johnson - for pioneering research on the physics of semiconductor materials and devices, and particularly for elucidating their complex reactions with hydrogen.

Silvanus S. Lau - for contributions to the understanding of metal-semiconductor interactions, including applications in microelectronics and optoelectronics.

Robert J. Nemanich - for contributions to the application of Raman spectroscopy to the study of atomic structure in semiconducting thin films and interfaces.

Julia M. Phillips - for contributions to the understanding of the growth mechanisms and properties of epitaxial heterostructures involving structurally and electrically dissimilar materials.

Cullie J. Sparks - for contributions to the development of x-ray optics, monochromators, and anomalous resonance scattering that have advanced synchrotron radiation studies of local atomic arrangements and displacements in crystals.

Rudolph M. Tromp - for contributions in determining the structure, bonding and formation of semiconductor surfaces and interfaces, and their role in numerous microscopic semiconductor materials issues.

Device Produces Ultrafine Ceramic Particles with Controlled Shapes

Developers of an electronic dispersion reactor (EDR) say their device can produce ultrafine ceramic particles of desired shapes and sizes. Ceramic powders of known size, shape, structure, and chemical composition could be the basis for fracture-resistant ceramics and ceramic composites. Control over shapes and sizes could also eliminate structural problems that diminish superconductivity in bulk superconducting materials and could improve the electrical current-carrying capacity of high-temperature superconducting materials.

The EDR's developers have used it to make particles of several different shapes and sizes, including "porous prune" and "PacMan™," two particles so dubbed because of their shapes. The goal with the EDR is to produce ceramic particles of a desired size or size distribution needed to achieve an optimum packing density.

In the EDR, electrical stresses accumulate and atomize metallic salts dissolved in water into droplets at the spray nozzle, resulting in a very fine mist. Its developers can make particles of different sizes and shapes by changing the location and concentrations of the reactants on the droplets and by changing the intensity of the electric field.

The EDR offers several advantages over conventionally used methods: It uses about 10% less energy, needs less maintenance because it has no moving parts, renders ceramic processing dust-free because the ceramic material is contained in a slurry phase, and minimizes waste products because the solvent is recycled through a continuous flow.

The EDR was developed at Oak Ridge National Laboratory by Michael T. Harris, Timothy C. Scott, and Charles H. Byers of the Chemical Technology Division. Harris and his associates conducted a demonstration production run of 130 grams of zirconia powder to show that the EDR could be considered for scale-up to industrial production. □

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Editor, MRS Bulletin, Materials Research Society, 9800 McKnight Road, Pittsburgh, PA 15237-6006, FAX (412) 367-4373

https://doi.org/10.1557/S0883769400036472 Published online by Cambridge University Press