Expanding the Comfort Zone: A Materials Scientist Experiences Life in the U.S. Department of State

Alex King

Jefferson Science Fellows are tenured academic scientists and engineers from U.S. institutions of higher learning who spend a year at the U.S. Department of State providing up-to-date expertise on scientific issues that affect decisions related to foreign policy and international relations. The JSF program was inaugurated in 2004, with funding from the MacArthur Foundation and the Carnegie Foundation, partly in response to an earlier report from the National Research Council that had identified the dwindling influence of science as a weakness in creating foreign policy for an increasingly technological world. The National Academies select the fellows and manage the program.

In the fall of 2004, the provost of my university nominated me for a Jefferson Science Fellowship, and by the early spring of 2005, I had been selected as one of the five members of the second class of fellows. May brought a formal introduction in the State Department's Diplomatic Reception Suite, and in August I moved to Washington, D.C., and began the process of finding a niche among the many bureaus and offices that make up the oldest executive branch agency of the U.S. government.

The organization is divided into bureaus that are either "functional" (like Arms Control or Economic Policy) or "regional" (like African Affairs or European & Eurasian Affairs). It is a formidable organization: 50,000 employees, with posts in most foreign countries and a headquarters building in Washington that covers two full city blocks, right across the street from the National Academies, where fellows can be lunchtime regulars, if they so choose, and rub shoulders with the country's scientific elite.

The challenge is to find an office that is interested in the services of a science fellow, that affords an opportunity to learn new things, and that offers a chance to have an influence on U.S. foreign policy. I made my home in the Africa Bureau, one of the five regional bureaus that cover the globe and report to the Undersecretary for Political Affairs.

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The first days brought an assortment of issues to my desk, apparently guided by a simple rule: "If it sounds like science, give it to Dr. King." The subjects bore little relationship to any specific expertise of my own, and included geothermal energy in the Great Rift Valley, "killer lakes" in Cameroon, "conflict diamonds," mineral extraction, and sanitary and phytosanitary (SPS) requirements for the importation of animal and vegetable products into the United States. In each case, the drill was more or less the same: learn the technological issues, then learn the political and policy issues by reading all the memos, briefings, and speeches on file. In short, become an expert in all aspects of the topic and then track and assess new information that arrives from all kinds of sources. Then provide appropriate information either on demand or when the fellow thinks it will be useful to inform a policy decision. Sometimes there is a short lead-time demand for information on a subject for which the fellow is not prepared. "Why do we have to import gum arabic from Sudan?" was one notable example. This can be a test of library research skills and the fellow's ability to explain the issues at a sixth-grade level of scientific literacy.

November brought a seemingly simple assignment to track information on avian influenza, which had not yet arrived in Africa but was predicted by many to be a threat to the lakes of East Africa. My own reading of the data was a little different, and I urged for vigilance in Central and Western Africa, too. February brought the first confirmation of an avian influenza outbreak—in Nigeria—and the mobilization of several U.S. government agencies and the world community to contain the spread of the disease. My role switched to being the coordinator of all U.S. government activities on avian influenza in Africa. The early weeks of building an expert team (with a lot of guidance from experienced diplomats) eventually gave way to a well-formulated and tested response plan that has been applied with differing local nuances in eight affected countries south of the Sahara. Supplies have been pre-positioned in all of the "at-risk" countries, too, to enable a rapid and effective response to any new outbreaks that may occur. Health care systems are not well-developed in Africa, but some remarkable successes have been achieved in containing this disease, even in the poorest of nations.

Throughout my tenure, I have tried to bring a focus on scientific and educational collaboration as a means of delivering development assistance, and I have managed to start some exchange programs targeting specific needs in Africa.

What does a materials scientist bring to a position like this? The interdisciplinary nature of our field certainly provides a good training for collaborative projects, and nearly all of the work I have done in the State Department has been highly collaborative, calling upon experts in a wide array of scientific and other fields. Our broad appreciation for different types of science and ability to make connections with experts from differing fields are also of great value.

The Jefferson Science Fellowship program provides an unusual opportunity to learn new things (often very unexpectedly), to interact with talented people from entirely different fields of endeavor, and with a little luck, to make a difference in

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the world. It will take fellows out of their own comfort zones, intrude them into some policy comfort zones, and maybe increase the well-being of the international community. It is more than worth considering. The experience of future fellows will mirror mine only in its unpredictability, but it will almost certainly be highly rewarding.

The upcoming application deadline is December 31, 2006 for fellowships starting in August 2007. Details about the Jefferson Science Fellowship program can be accessed at Web site http://www7.nationalacademies.org/Jefferson/.

For me, it's back to "real life" at Purdue University for the fall semester, but real life will never be quite the same again.

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RESEARCH/RESEARCHERS

Dye-Sensitized Solar Cells Fabricated with Liquid Organic Semiconductor Achieve Relatively High Efficiencies

Since their introduction 15 years ago, solar cells based on dye-sensitized mesoporous layers of TiO_2 have attracted attention as a potentially greener alternative to silicon-based solar cells. However, a major stumbling block in the path toward more efficient dye-sensitized solar cells (DSCs) is the difficulty of infiltrating solid-state semiconductor material into the TiO_2 to carry away liberated charge. Now, H.J. Snaith and colleagues from École Polytechnique Fédérale de Lausanne, Switzerland, have used a liquid organic semiconductor in the construction of DSCs, finding that the resulting devices have relatively high efficiencies.

As reported in the September issue of *Nano Letters* (p. 2000; DOI: 10.1021/nl061173a), the researchers first characterized the liquid organic semiconductor tris-[4-(2-methoxy-ethoxy)-phenyl]-amine (TMEPA), finding the highest occupied molecular orbital at −5.34 eV below vacuum, suitable for hole transfer from the oxidized dye molecule K51. To fabricate the solar cells, they screen-printed a 2.5-μm-thick mesoporous layer of TiO_2 nanoparticles with ~20-nm average diameters on a fluorine-doped SnO_2 glass sheet. The nanoparticles were coated with K51 dye molecules and overlaid with a 20-μm Surlene spacer and a gold-coated conducting cathode. These "empty" cells were then filled with 20 μl of *p*-doped TMEPA by pumping on them under vacuum to remove air bubbles and returning them to air pressure to force the TMEPA into the cell. The finished cells showed solar power conversion efficiencies of 2.4–3% for illumination intensities between 10 mW/cm^2 and 100 mW/cm^2. The incident photon-to-electron quantum efficiency was very high (over 50%), but this value fell off at higher illumination intensities and thus did not translate to a high power-conversion efficiency. The team is currently working to cross-link the semiconductor after fabrication to convert the solar cell to a fully solid-state device. Given these results, liquid organic semiconductors rather than those in the solid state may become the standard for dye-sensitized solar cell fabrication and may one day help replace silicon photovoltaics with DSCs.

Colin McCormick

Artificial Muscles Employed to Build Tunable Diffraction Gratings

Until now, the most successful tunable diffraction gratings with applications in telecommunication and display devices relied on standard hard materials. A. Stemmer and M. Aschwanden from the Nanotechnology Group of the Swiss Federal Institute of Technology have demonstrated a low-cost, electrically tunable diffraction grating based on soft electroactive polymer actuators, also known as artificial muscles. As reported in the September 1 issue of *Optics Letters* (p. 2610), the researchers developed a polymer-based device with an angular tuning range of 118 mrad for the first diffraction order, in comparison with the 486 μrad achieved with analog tunable diffraction gratings based on hard piezoelectric actuators. In this device, light diffracts in gratings whose grating period can be changed up to 32%. When combined with white light sources, they can be used as wavelength-tunable luminous sources that may lead to the development of inexpensive, natural color displays when integrated into optical microelectromechanical systems.

The researchers fabricated the dielectric elastomer actuator by pre-straining and mounting on a holder an acrylic elastomer film and contact printing compliant carbon electrodes with a poly(dimethylsiloxane) stamp coated with carbon black. They spin-coated a 20-μm-thick elastomer film onto a holographic diffraction grating master with 1000 lines/mm to create the elastomeric diffraction grating. This film was placed onto the dielectric elastomer actuator, where it remained bonded after curing at 50°C for 60 min. The grating master was then peeled off of the elastomeric film, and a 6-nm-thick, reflection-enhancing gold layer was then evaporated onto the diffraction grating.

When the researchers applied a voltage between the two compliant electrodes, the charges that built up at the elastomer–electrode interfaces established an electric-field pressure that induced a compression in thickness and an elongation of the elastomer film in the planar directions. When white light from a collimated tungsten halogen lamp with a spot size of 0.5 mm was directed at a fixed incidence angle onto the center of the tunable diffraction grating, the researchers observed that they were able to tune the wavelength of the first-order diffracted spot from 446 nm to 585 nm (a tuning range of 139 nm) over a voltage range from 0 kV to 4.5 kV. Stability tests (30,000 cycles) showed no degradation in reflectivity and no peeling of the gold layer.

The researchers said, "because of the wide tuning range, the demonstrated device is not only interesting for display applications but also for other optical systems such as low-cost tunable lasers."

Joan J. Carvajal

Carbon Nanohorns Made Soluble through Covalent Chemical Modification

Laser ablation of graphite produces carbon nanohorns (CNHs) in high yield. CNHs not only differ from single-walled carbon nanotubes (CNTs) in their shape; CNHs are free from impurities and do not require purification that results in degradation and reduced mechanical and electronic properties. Like CNTs, however, CNHs are completely insoluble in organic solvents and in aqueous media. Recently, N. Tagmatarchis and graduate student G. Pagona at the National Hellenic Research Foundation in Athens, Greece, together with J. Fan and co-researchers from the Japan Science and Technology Agency and NEC Corp., both in Ibaraki,