should be conducting because both have a surface state at the Fermi energy.

The researchers concluded that a larger fraction of current runs in the space charge region for the microscopic probe, and that a larger fraction of current runs in the surface states. An estimate of the conductivity of the surface states can be deduced from the difference in conductance between the microprobe measurement and the theoretical prediction for band bending alone. The result is comparable more to conductivities for bulk materials such as bismuth. Since in this case the $\sqrt{3}\cap\sqrt{3}$ structure has no relationship with the metallic silver, it means that the conductivity result obtained is not due to a thin metallic film, but is an intrinsic property of the surface reconstruction.

CLAUDIU MUNTELE

Holographic Two-Photon Polymerization Increases Speed of Switchable Gratings

The fabrication of electrically switchable gratings consisting of periodic sheets of liquid crystal (LC) droplets and polymer has been reported by Senior Materials Research Engineer Timothy Bunning and his team from the Air Force Research Laboratory. These structures allow the rapid switching of information between two different states and thus possess great importance in the telecommunications, display, and computing industries. Gratings were fabricated by holographic two-photon induced photopolymerization (H-TPIP) of a homogeneous syrup mainly consisting of dipentaerythritol pentaacrylate (DPHPA) monomer and liquid crystal molecules. The resulting periodic structure exhibits diffraction due to a periodic refractive index modulation; however, the intensity of the transmitted and diffracted beam can be varied by applying modest electrical fields to reorient the LC molecules, thereby changing the refractive index modulation. The H-TPIP process used by the AFRL team takes advantage of the nonlinear absorption of ultrafast laser pulses which can be raster scanned in three dimensions to write complex structures. The advantage of H-TPIP over conventional one-photon holographic processes is the much smaller local volume excited which allows sharper, more delineated local phase separation to occur.

As reported in the October issue of *Chemistry of Materials*, the grating was fabricated by irradiating a reactive mixture of the DPHPA monomer, bis(diphenylamino) diphenyl hexatriene initiator, N-vinyl pyrrolidinone reactive diluent, and nematic LC E7. The reactive mixture was sandwiched between two indium-tin-oxide-coated glass slides at a thickness of 8 μm. The spatial and temporal overlap of two 90-fs laser pulses (950 μJ, 500 Hz repetition rate, λ = 800 nm, spot size 7 mm^2) induced photopolymerization through a free radical initiation process (H-TPIP). The free radicals were produced by the transfer of excited electrons from the initiator to the DPHPA anion following two-photon absorption. The polymerization was allowed to proceed for up to 60 s.

Both optical and scanning electron microscope techniques were used to analyze the resulting polymerized structures. Polarized transmission microscopy of the grating revealed a polymer film with a grating spacing of about 3 μm. Low voltage scanning electron microscopic (LVSEM) analysis of the grating cross-sections confirmed the period and revealed phase-separated, LC domains on the order of 20–200 nm in size. Only 25–30% of the grating period was composed of the LC-rich phase with the remainder of the structure being cross-linked polymer.

Previous work by the same researchers using one photon holographic polymerization produced a grating period composed of a much larger fraction of LC-rich domains. According to the researchers, the improved phase separation presented in this work is the result of the H-TPIP initiating a much smaller volume of the reactive mixture. Thus the distribution of initiating species is much different than in the one-photon holographic case. This skewed radical distribution modifies the resulting polymerization and phase separation dynamics relative to diffusion.

According to Bunning, these results

Alan Krauss passed away on June 26, 2000 after a courageous battle against cancer. He was a Senior Scientist and Group Leader at Argonne National Laboratory, where he had a distinguished career making major contributions to various interdisciplinary fields of research and technology development.

Alan was one of those scientists who embodied a deep knowledge of several fields of research, which included ion and plasma interaction with solids and gases, materials science (including bulk materials and thin films), and the invention and development of unique instrumentation which made a critical impact on the advancement of materials, surface and thin film science.

The experimental and theoretical work of Alan Krauss in these fields contributed to opening new avenues of research and to new technological developments. In this respect we can cite four major scientific and technological developments among Alan's contributions.

He helped develop the science and technology of unique alkali metal-based alloys, which made a major impact in the science and technology of fusion energy devices as well as on thin film-based cold cathodes for many important technologies such as field emission flat panel displays and high frequency devices. He was the co-developer of a unique microwave plasma technique to produce nanocrystalline diamond thin films. He made major contributions to the science and technology of multicomponent oxide thin films (e.g., high temperature superconductors and ferroelectrics), and he was a co-developer of a unique time-of-flight ion scattering and direct recoil- spectroscopy surface analysis technique, which for the first time can be used in relatively high-pressure environments.

Alan Krauss was not only a top scientist, but he also was one of those rare human beings who had an open mind and a gentle attitude toward his colleagues and other scientists. He always contributed to scientific discussions with constructive criticism and with challenging ideas. We as colleagues valued very much his positive approach to scientific discussions. Also, we could count on Alan when requesting from him contributions to conferences, invited papers, or articles for books. Alan was an excellent teacher. He directed numerous theses of graduate students from several universities in the United States. Those students went on to successful careers and in turn established scientific relationships and joint programs with Alan, which speaks for itself about the lasting legacy of his teaching.

Alan Krauss received several awards for his scientific accomplishments, and he was author or co-author of five patents and 11 patents pending. He published numerous papers and edited books that will provide continuous inspiration to colleagues and students for years to come. His scientific talent, dedication, warm personality, and friendship will be deeply missed.

ORLANDO AUCIELLO
Argonne National Laboratory

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demonstrate the potential of H-TPIP to control the resulting morphology (both domain size and domain distribution) in phase-separated diffractive structures. Because of the nonlinear and local nature of the process, the formation of phase separated-diffractive structures internal to a surrounding medium is also potentially possible. Thus, one might envision writing complex optical structures (such as lenses) in the interior of a surrounding solid material using this holographic technique.

GREG KHITROV

Fullerenes Control Grain Size and Orientation in Nanomagnetic Thin Films

Most investigations into fullerene (C_{60}) applications have involved doping either the interior or exterior of the fullerene cage with other atoms to achieve unique properties. Now researchers at Rice University and the National Institute of Standards and Technology (NIST) have succeeded in synthesizing nanomagnetic thin films of Co, Fe, and CoFe by co-deposition with C_{60} to control the grain size, grain orientation, and magnetic properties of the resulting films. Magnetization curves show high out-of-plane remanence, high coercivity, and fast magnetic switching properties.

As reported in the November 13 issue of *Applied Physics Letters*, samples were prepared by simultaneously subliming high purity C_{60} powder at 500–650°C and evaporating Co and Fe from pure metal rods in an ultrahigh vacuum. Thin films of Co, Fe, Co-C_{60}, Fe-C_{60}, and CoFe-C_{60} of 100 nm thickness were deposited on amorphous-silicon-nitride-coated Si substrates, then analyzed using wavelength dispersive spectrometry (WDS), mass spectrometry, Raman spectrometry, transmission electron microscopy (TEM), and vibrating sample magnetometer (VSM).

Using WDS, the atomic compositions of two promising films were shown to be $Co_{162}C_{60}$ and $Fe_{73}C_{60}$. Mass spectrometry revealed high concentrations of C_{60} in these samples, with very little decomposition product, demonstrating the stability of C_{60} in the metallic matrix. TEM images of the $Co_{162}C_{60}$ sample showed highly columnar Co grains of 11 nm diameter, much finer than the 22 nm grains obtained in the pure Co film. A carbon-containing phase identified as C_{60} filled the grain boundaries. Similarly, the $Fe_{73}C_{60}$ film had a finer diameter (5 nm) than the pure Fe film (15 nm). The grains in the $Fe_{73}C_{60}$ film were approximately 50 nm long, and were oriented perpendicularly to the substrate. In contrast, the grains in the pure Fe film were randomly oriented.

The investigators attribute the controlled microstructure to a self-assembly grain growth model involving migration of C_{60} to the edges of metallic nuclei, formation of an interconnected C_{60} structure that confines the metal atoms and a subsequent build-up of layers of metal atoms surrounded by C_{60} after the thickness of the previous layer is exceeded.

Possible applications of this research include magnetic memory devices, magnetic switches, spin valves, and magnetic springs.

TIM PALUCKA

Surface Conductivity in Hydrogenated Diamond Requires Exposure to Air

In their study of the origin of surface conductivity in hydrogenated diamond, researchers at the Institut für Technische Physik, Universität Erlangen, Germany, have asserted that chemisorbed hydrogen is a necessary but not sufficient condition to create a hole accumulation layer that causes surface conductivity. Their experiments demonstrate that an additional adsorbate from the atmosphere is needed to induce the surface hole accumulation

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