of the sample surface increased from a value between –5.6 and –3 to a pK_a of –1.2. The pore volume decreased after surface modification from 0.143 cm^3/g to 0.083 cm^3/g, indicating that the sulfonic groups covered the pore surface of the sample. The conductivity of the samples was measured at 95% and 100% relative humidity at temperatures ranging from 40°C to 120°C. The maximum value of conductivity was 4.2×10^{-2} S/cm at 120°C and 100% relative humidity. Under these conditions and after being in contact with methanol, the sample did not suffer any degradation. The research team reports that these results show the good mechanical and thermal stability of the material, making it a good candidate for electrolyte membranes in the direct methanol fuel cell.

This ionic conductive material overcomes the limitations in operating temperature and water swelling of currently used proton conductive membranes such as Nafion. The researchers said that the thermal stability of their material originates from the thermal stability of porous glass and the covalent bond formed between the organic molecules and the glass surface.

"By this process, we can obtain well-designed organic–inorganic nano hybrid materials," Yazawa said.

MARIA CORTALEZZI

Garnet/SOI Magneto-Optical Devices Fabricated by Direct Wafer Bonding

Silicon-on-insulator (SOI) is an attractive substrate for dense integrated optical circuits because of its high index contrast, which allows small, high-performance components such as waveguides, bends, splitters, and modulators. In addition, SOI substrates allow seamless integration with electronics for on-chip optical devices. Current integration schemes for garnet–semiconductor devices are insufficient due to the difficulty of alignment with active devices on the semiconductor substrate or small nonreciprocal phase shifts, requiring long device lengths. In the May 1 issue of *Optics Letters* (p. 941), R.L. Espinola of Columbia University, H. Dötsch of the University of Osnabrück, and their colleagues have reported an integrated magneto-optical (MO) device design consisting of a garnet film directly bonded to SOI waveguides. Theoretical predictions indicate their design can achieve a threefold enhancement of the nonreciprocal phase shift over previous designs.

Optical isolators or circulators are important components for photonic integrated circuits. To date, neither has been developed in SOI or any integrated materials platform. Optical isolator research generally focuses on the MO effect in a magnetic garnet film. A promising concept depends on the nonreciprocal phase shift—the difference between the forward and backward propagation constants. To measure the nonreciprocal phase shift, the researchers fabricated thin Si waveguides onto an SOI wafer with e-beam lithography, thermal evaporation, and reactive ion etching. Bismuth-lutetium-neodymium-substituted iron garnet (BiLuNd-IG) was deposited epitaxially on gadolinium gallium garnet, and then bonded to Si waveguides by using a direct wafer-bonding technique. The BiLuNd-IG layer showed an optical loss of 12.6 dB/cm. Optimizing the growth conditions for the garnet materials can result in absorption losses as low as 0.5 dB/cm.

The researchers have demonstrated that miniaturized integrated devices, such as optical isolators and circulators, are possible by directly bonding SOI waveguides and a magneto-optical material. They said that the use of a standard semiconductor substrate simplifies the materials design for large-scale photonic integrated circuits.

JEREMIAH ABIADE

Mullite Powders Produced by Heterogeneous Nucleation

Fabrication of ceramic components usually involves the sintering of fine powders by various methods that ensure a homogeneous particle size distribution. Additionally, in the case of composite materials, a homogeneous distribution of the second phase becomes key in obtaining a high-quality product with the desired properties. Mullite ($3Al_2O_3 \cdot 2SiO_2$) is a ceramic material widely used in electronic applications, and a wide variety of methods are available for preparing mullite powders. Heterogeneous nucleation has been proposed as an alternative technique by Y.F. Tang of Nanjing University, Z.D. Ling of Nanjing University of Technology, and their colleagues. These investigators have developed a technique to process fine mullite powders from alumina particles coated with amorphous silica. With this method, they delivered a highly homogeneous fine powder, as they explain in the March issue of the *Journal of the American Ceramic Society* (p. 520).

With a combination of α-alumina particles with an average size of 0.26 μm and tetraethylorthosilicate, the investigators formed a supersaturated silica sol suspension. Transmission electron microscopy revealed a silica layer of ~20 nm on each alumina particle, formed by heterogeneous nucleation and growth. They calcined the composite particles in 50 g batches, in temperatures ranging between 1400°C and 1600°C, and then ball-milled the resulting powders with alumina ceramic balls for 6 h.

X-ray diffraction (XRD) patterns revealed that the choice of temperature used to calcine the powders influenced the type of phase and amount present. After calcinations for 2 h at 1400–1450°C, the researchers observed small amounts of cristobalite and corundum together with mullite as the larger constituent. Even after calcining for 48 h, cristobalite and corundum were still present. At 1500°C, the powders were exclusively mullite and as the temperature was increased to 1600°C, the XRD pattern peaks sharpened. The single-phase mullite obtained showed a fine uniform particle size distribution with an average particle diameter of 0.53 μm, as observed by scanning electron microscopy.

SIARI SOSA

Vertical InP Nanowire Arrays Fabricated by Nanoimprint Lithography

Semiconductor nanowires have been widely studied in the applications of electronics (such as resonant tunneling diodes and single-electron transistors), photonics (such as light-emitting diodes), and life science. Numerous studies have focused on how to control the growth of nanowires in arrays and understand their electrical and optical properties. T. Mårtensson, L. Samuelson, and their colleagues from the Nanometer Consortium at the Lund University, Sweden, have implemented nanoimprint lithography in order to fabricate arrays of vertical semiconductor nanowires.

Nanoimprint lithography achieves comparable results as electron-beam lithography, but at a lower cost and with higher throughput. As reported in the April 14 issue of *Nano Letters* (p. 699), a stamp was made on a silicon wafer using electron-beam lithography and dry etching in a SF_6/O_2 atmosphere. A double resist layer consisting of a PMMA950k layer over a lift-off ZEP520A7 film was exposed by the electron beam. Next, 30 nm of chromium was evaporated on the developed resist and then lifted off. The chromium then served as a mask for the reactive ion etch. After such treatments, columns with a height of 300 nm and a top diameter of 200 nm were arranged in a hexagonal pattern with a nearest-neighbor distance of 1 μm on the silicon wafer. Wet etching was used to remove the remaining chromium. A monolayer of tridecafluoro

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(1,2,2,2) tetrahydrooctyltrichlorosilane was then deposited as an anti-sticking agent. Gold dots, which are the catalyst to control the later nanowire (InP) growth, were then patterned by metal evaporation and lift-off. The nanowire was formed in a metalorganic vapor-phase epitaxy system by a vapor–liquid–solid growth technique. Scanning electron microscopy showed that the nanowires were ~1.5 µm long with a diameter of ~290 nm.

By combining the nanoimprinting and self-assembly of nanostructures, this technique may be used to design nanowires by controlling the size of the catalyzing gold particles, which determines the diameter of the wires, said the researchers. It can also govern the length of the wire by the control of the growth time. The researchers said that this technique would provide a method for fabricating monolithic nanoimprint lithographic stamps and expanding the application areas of nanowires as well.

LUCY YUE HU

News of MRS Members/Materials Researchers

Aldo R. Boccaccini, of Imperial College London, received the **Materials Science and Technology Prize 2003** from the Federation of European Materials Societies (FEMS) for "his contribution as a most promising and talented young materials scientist."

Greg Boebinger, of Los Alamos National Laboratory, has been named director of the National High Magnetic Field Laboratory (NHMFL). Boebinger previously served as the director of the pulsed magnet facility at Los Alamos; he succeeds Jack Crow, who was director of the NHMFL since its founding in 1990.

Theodorian Borca-Tasciuc, director of the Nanoscale Thermophysics and Energy Conversion Laboratory (NanoTEC) and assistant professor of mechanical, aerospace, and nuclear engineering at Rensselaer Polytechnic Institute has been awarded a **Faculty Early Career Development Award (CAREER)** from the National Science Foundation.

Scott Chambers, of the U.S. Department of Energy's Pacific Northwest National Laboratory, has been selected as the 2004 recipient of the **E.W. Mueller Award** from the University of Wisconsin for outstanding research in surface science. He is being recognized for advancing the science of molecular-beam epitaxy and applying it to fundamental investigations of the structural, electronic, and magnetic properties of metal oxide films, surfaces, and interfaces.

C.J. Ellison and J.M. Torkelson, of Northwestern University have received the **2004 Wiley Journal of Polymer Science (Part B) Prize** for their article, "Sensing the Glass Transition in Thin and Ultrathin Polymer Films via Fluorescence Probes and Labels," published in the December 15, 2002, issue of the *Journal of Polymer Science, Part B: Polymer Physics* **40** (24) p. 2745. The award honors the best paper published in the journal during the previous two years.

Diana Farkas professor of materials science and engineering in the College of Engineering at Virginia Tech, received the university's **2003 Alumni Award for Excellence in Research**.

Terence Langdon of the University of Southern California (USC) has been named the William E. Leonhard Professor of Engineering at USC. He was also elected a fellow of the Royal Academy of Engineering (U.K.) and awarded the degree of *doctor honoris causa* by the Russian Academy of Sciences.

Jyotirmoy Mazumder, of the University of Michigan, Ann Arbor, received the **2003 Arthur L. Schawlow Award** from the Laser Institute of America in recognition of his outstanding contributions in the applications of lasers for science, industry, and education.

David Miller, of The Pennsylvania State University, has received the **MBE Innovator Award** from the North American Molecular Beam Epitaxy (NAMBE) organization, an award co-sponsored by Veeco Instruments Inc., for inventing arsenic capping and the valved arsenic cracker while employed at the Rockwell Science Center and, later, at Penn State.

Charles Ramiller of IBM has been named by International SEMATECH as director of its Front End Processes (FEP) Division, which provides robust, cost-effective FEP manufacturing capability and supports continuous complementary metal oxide semiconductor scaling to and beyond the 45 nm technology node.

Nancy Ross, professor of mineralogy in the College of Science at Virginia Tech, has been named the college's associate dean for research, graduate studies, and outreach.

J. Michael Rowe, of the National Institute of Standards and Technology Center for Neutron Research (NCNR), is the recipient of the **Clifford G. Shull Prize in Neutron Science** from the Neutron Scattering Society of America

Kristi Anseth Receives NSF Waterman Award

Kristi Anseth, a chemical engineer at the University of Colorado at Boulder, has received the National Science Foundation (NSF) **Alan T. Waterman Award**, the foundation's most prestigious honor for a young researcher. The award includes a medal and a $500,000 grant over a three-year period to carry out research or advanced study in the field and institution of her choosing. Anseth's award is based on her groundbreaking work in new biomaterials that are engineered to help the body heal itself.

Anseth's group has developed light-activated biomaterials that degrade and interact with cells while promoting tissue regrowth. The hope is that these biodegradable, flexible materials may be available within a decade for medical procedures that will allow the "injection" of new body parts into patients who suffer from debilitating injuries or diseases—without the trauma of major surgery.

Prior awards for Anseth come from many sectors. She earned a Colburn Award from the American Institute for Chemical Engineers as the most outstanding individual in that field under age 36. She received the 2001 Materials Research Society Young Investigator Award. She also received an NSF Faculty Early Career Award (CAREER) to develop a new class of polymers that can be used for orthopedic applications, such as bone repair. Anseth is on the Board of Directors of the Materials Research Society.

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