solution. Water shifts the conversion toward α-Al_2O_3, which is a transition structure.

As reported in the September issue of the *Journal of the American Ceramic Society*, the investigators mixed high-purity aluminum isopropoxide with diethylene glycol monoethyl ether and acetic acid, and then produced the gel, which was deposited on silicon wafers. They compared two coating procedures: standard dip-coating and dip-coating combined with a fast thermal treatment.

A series of x-ray diffraction (XRD) patterns showed the development of the crystallization process in which the first crystalline phase to appear is γ-Al_2O_3 after annealing for 30 h at 700°C. Simultaneous formation of α-Al_2O_3 started after annealing for 30 h at 800°C. The amount of α-Al_2O_3 increased with temperature until it was 100% α-Al_2O_3 after annealing for 30 h at 950°C. Regarding the amount of time needed for complete conversion, the XRD pattern series showed that at 950°C, it was 10 h, at 1000°C it was 2 h, and at 1100°C it was only 1 h. These are very short times compared with standard procedures.

Concerning the differences in the applied coatings, crystallization occurs only in the coatings exposed to the rapid thermal treatment, as revealed by x-ray analysis. Bahlawane and Watanabe suggest that diffusion of Si on the film during the slow drying, observed after energy dispersive x-ray analysis of these films, prevents recrystallization of α-Al_2O_3, therefore leaving the amorphous film of Al_2O_3 and Si.

SIARI S. SOSA

Two-Dimensional Macroporous-Silicon Photonic-Crystal Waveguides with Large Mid-Infrared Transmission Bandwidth Fabricated

Researchers from the University of Toronto, the Max-Planck-Institute of Microstructure Physics, and the Massachusetts Institute of Technology have fabricated and demonstrated the operation of a new type of optical waveguide made in a photonic crystal. As they report in the October 15 issue of *Optics Letters*, their silicon waveguide efficiently guides and confines infrared light using a photonic bandgap.

A two-dimensional silicon photonic crystal was fabricated in macroporous silicon by lithography and wet etching techniques. A triangular lattice of 100-μm-long cylindrical pores, with a spacing of 1.5 μm, was formed in a silicon wafer. The resulting two-dimensional photonic crystal had a photonic bandgap (a spectral region over which the propagation of light is inhibited) spanning 3.1–5.5 μm in wavelength for light polarized along the axis of the pores. By leaving out a row of pores, a one-dimensional defect was created in the lattice, forming a narrow 1 μm waveguide cladded by the two-dimensional photonic crystal. Light from a parametric source was focused onto the entrance of the waveguide, and the transmission spectrum was measured over the bandwidth of the bulk crystal photonic bandgap.

The measured spectrum showed a very large transmission bandwidth nearly equal to that of the bulk crystal bandgap, in agreement with calculations. Furthermore, based on the agreement between theory and experiment, single-mode operation of the waveguide is predicted with a bandwidth of 10%. This bandwidth is significantly larger than that of current fiber-optic systems. These results demonstrate the use of photonic crystals to confine and guide light on the micrometer scale. Unlike traditional waveguides, which employ total internal reflection for light confinement, the photonic bandgap confinement mechanism allows for tight waveguide corners and a high density of optical integration. According to the researchers, photonic-crystal waveguides therefore represent an exciting technology for next-generation optical circuits.

JUNE LAU

Bohrium 267 Compound Found to be Volatile at 180°C

An international collaboration of radiochemists has determined the volatility of bohrium, element 107. According to their article published in the September 7 issue of *Nature*, the team, led by Heinz Gaggeler of the University of Bern and the Paul Scherrer Institute (PSI) in Villigen, Switzerland, created bohrium 267 at PSI's PHILIPS cyclotron. They used a beam of neon 22 to bombard a target of berkelium 249, which has a half-life of 320 days.

Immediately after bombardment, the reaction products were swept into an automated system where they formed molecules in oxygen-containing hydrogen chloride gas. These oxychlorides were then passed through a chromatography column, in which the more volatile species pass through at lower temperatures.

During the month-long experiment, about three atoms of bohrium were creat-

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ed for each day of beam time, but only six bohrium nuclei were actually detected. The bohrium 267 compound was shown to be volatile at 180°C, behaving much like its periodic-table relatives technetium and rhenium.

Crystal-Bonding Principles Established for Compounds Such as Neodymium Distannide

Researchers at Cornell University have established the principles of crystal-bonding of a group of thousands of compounds that carry significant electronic and magnetic properties.

"This is an important step in understanding the bonding in alloys and intermetallic compounds," said Roald Hoffmann, Nobel Laureate for chemistry (1981) and the Frank H.T. Rhodes Professor in Humane Letters at Cornell. Working with postdoctoral researcher Garegin Papoian, Hoffmann laid out a theory that extends the understanding of bonding in a particular class of alloys.

As reported in the July 17 issue of *Angewandte Chemie*, the two researchers began by looking at the bonding of compounds of antimony, tellurium, tin, and selenium. The compounds have names like europium, lithium antimonide, and neodymium distannide, and although they have been known for many decades, "experimentalists have said nothing about what holds these compounds together," said Hoffmann.

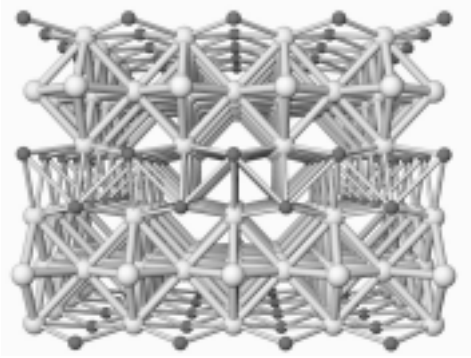

Figure 1. A perspective view of the crystal structure of neodymium distannide, a compound of tin and the rare-earth metal neodymium. The small dark spheres are neodymium, and the large light spheres are tin. Credit: Garegin Papoian. © 2000 Cornell University.

These compounds consist of a melange of metallic, covalent, and ionic bonds that the researchers explain in a formula based on "magic numbers." In their bonding formula, magic numbers are the electron counts that indicate whether a stable compound is linear or square: seven electrons per atom for a linear chain; six electrons per atom for a two-dimensional square lattice; and five electrons per atom for a simple cube lattice (see Figure 1).

The crystal structures themselves can be seen in a series of computer-generated drawings—not based on theory, but on direct experimental work—that have an interlocking, architectural perfection. The molecular structures, ranging from simple geometries to complex lattices, reveal their bonding networks in a series of multidimensional building blocks.

Hoffman said, "Some look terribly complicated, but take them apart and you can see square lattices with atoms above and below, and squares forming octahedrons."

Hoffman said that such structures reveal themselves sometimes as com-

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