(FWHM), at a position 93 cm downstream from the CRL using 6.5-keV photons. The spot diameter was larger than expected, which was attributed to surface irregularities or the uncertainty of the source.

The Gaussian transmission profile FWHM of the Be CRL was also measured by scanning a 25 μm × 25 μm beam across the CRL and was determined to be 321 μm with on-axis transmission of 9% at 6.5 keV photon energy. The attenuation aperture was thus calculated to be 607 μm. Consequently, using the experimental data, a gain of 1.5 was calculated for this lens, compared with a theoretical value of 6. The obtainable gain is dependent on the source size used for the experiments, and much higher gains would be expected from third-generation and beyond x-ray facilities.

According to the researchers, the use of CRLs made of beryllium "can achieve submeter focal lengths at lower x-ray energies (~6.5 keV) than for previously reported CRLs and still have what are believed to be the largest reported apertures (~600 μm). Thus, it is expected that Be CRLs can outperform lenses constructed of higher-atomic-number materials at energies below 30 keV."

CALIN MICLAUS

Heating Allows Birefringence Tuning in Microstructured Optical Fibers Partially Filled with a Polymer

Recently, researchers have shown that microstructured photonic-crystal optical fibers (MOFs) formed by incorporating air holes running along the length of the fiber can enable additional control of birefringence, dispersion, and nonlinearity of the fibers. Among other novel techniques, introducing active materials into the air holes of microstructured optical fibers (MOFs) improves the capabilities of the devices fabricated. As they demonstrate in their article in the May 15 issue of *Optics Letters*, C. Kerbage, B.J. Eggleton, and co-workers from OFS Fitel Laboratories (now OFS Laboratories) in New Jersey, were able to induce and tune birefringence in MOFs.

The researchers chose MOFs comprised of a central germanium-doped core, 8 μm in diameter, encircled symmetrically by six air holes. They fabricated an all-fiber polarization controller, 125 μm in diameter but tapered along 1 cm of the length down to ~30 μm in diameter. This was to ensure that the mode to guide light was by total internal reflection at the silica-air-hole interface. The fiber was tapered adiabatically to achieve low intrinsic loss. Since MOFs with a rotational symmetry larger than twofold are not birefringent, the scientists had to break the sixfold symmetry by filling two opposite air holes with an acrylate-based polymer. The monomer filling, limited to the tapered area, was fed at 0.01 cm/s and cured using UV rays for 15 min. The resulting polymer had a refractive index of 1.434 at ambient temperature and at a wavelength of 1550 nm, although it is temperature-dependent ($dn/dT \sim -4 \times 10^{-4}\ °C^{-1}$), and hence is controlled by heating. After placing the device in a capillary heater, the research team applied a 1550-nm polarized laser beam to the fiber to yield an output light beam, which was analyzed for its polarization properties and converted into the Stokes parameters. Results after heating increments were expressed as a rotation of the Stokes vector, and all results were plotted on the Poincaré sphere.

The beam propagation method (BPM) simulated the distortion in the mode fields of this structure. Calculations performed using BPM were close to the experimental results. When the index is lower than that of silica, the light is guided by total internal reflection, and birefringence is low. When the infused polymer has an index near to that of silica, the mode of reflection becomes more asymmetric, and birefringence increases. Analysis of the polarization measurements using the Poincaré sphere show three rotations (6π) along the heating range of the capillary heater. Also, as the researchers reported, the calculated birefringence change reached $\sim 4.4 \times 10^{-4}$, and the tuning coefficient was ~15 rad/m °C. Hysteresis effects were negligible.

SIARI S. SOSA

Osmium Exhibits Lowest Experimentally Determined Compressibility

A group of researchers at Lawrence Livermore National Laboratory have determined through experiment and theoretical calculations that the element osmium (Os) has a lower compressibility (or higher bulk modulus B_0, the reciprocal of compressibility) than diamond, the hardest and least compressible material known to date. As reported by H. Cynn and co-workers in the April 1 issue of *Physical Review Letters*, the experimentally determined value of B_0 for osmium is 462 GPa, compared with 443 GPa for diamond. Artificially quenched metastable phases of ZrO_2 and TiO_2 have been reported to have bulk moduli close to that of diamond at best. A simple chemical bonding model and estimates based on the cohesive energy have suggested that Os should have a large B_0. In addition, Os has the highest Vickers hardness among the 5*d* transition metals.

Using synchrotron x-ray sources at the National Synchrotron Light Source (Brookhaven National Laboratory) and the Stanford Synchrotron Radiation Laboratory (Stanford University), diamond-anvil cell-compression studies were carried out for three transition metals: ruthenium (Ru), iridium (Ir), and osmium. Condensed Ar was used as a pressure medium. Pressure information was determined using luminescence from ruby grains (grain size <3 μm). Powder samples of Ru, Ir, and Os (grain size <5 μm) were packed into a small hole drilled into a rhenium gasket. Synchrotron x-ray diffraction measurements yielded lattice compressions.

A plot of the reduced volume as a function of pressure using the Birch–Murnaghan equation of state (EOS) fits for the three test materials, as well as for tungsten and diamond, shows that Os exhibits the least contraction as the external pressure is increased. The Holzapfel and Vinet EOS models were also applied to the experimental data to ensure consistency of the results for B_0. The three fitting algorithms all yielded identical results, in order of decreasing compressibility: Ru, Ir, diamond, Os. Theoretical estimates of B_0 were obtained using a full-potential linear muffin-tin orbital method to calculate the EOS. The calculated values of B_0 for the 5*d* transition metals show the same trend as the experiments.

According to the research team, this result opens new possibilities in the search for superhard materials among transition-metal compounds and alloys.

JUNE LAU

Nanoparticle Mediates Improvement in Si Electroluminescence Efficiency

Researchers at National Taiwan University have obtained a several-orders-of-magnitude electroluminescence (EL) efficiency increase from a metal oxide semiconductor (MOS) tunneling diode by replacing the oxide layer within the device with a layer of SiO_2 nanoparticles (NPs). C.F. Lin and co-workers have determined that the improved EL is the result of an increase in the density of radiative recombination states in the diode that stems from the spatial confinement of the charge carriers in the nanoparticles. The EL efficiency improvement allows for the use of Si in optoelectronic devices.

As described in the May 1 issue of *Optics Letters*, the researchers prepared the tunneling diodes to study the improvement by first removing the oxide layer from Si wafers. This was followed by spin-coating 12-nm SiO_2 NPs onto the wafers. Al was evaporated on top of the NP layer

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