this material was 92% of the theoretical density, and x-ray images show a uniform carbon distribution. High-resolution transmission electron microscopy observations showed several crystalline C_{60} particles as intergranular precipitates, but most of the carbon present formed a thin film covering the zirconia grains. The carbon present in these films was either graphitic or amorphous carbon, with a film thickness between 3 nm and 10 nm. The Vickers hardness of the composite specimen was a factor of 6 smaller than that of stabilized zirconia ceramics. The researchers suggest that the graphitic/amorphous carbon film is responsible for a reduction in the mechanical properties of this material, particularly in the hardness. However, they also said that, with further research, this material may have applicability as electric-conductive and wear-resistant fine solid lubricants in the future.

SIARI S. SOSA

Antimatter Generated Using Table-Top Laser System

Recent progress has been rapid in the field of table-top laser technology. Focused intensities approaching 10^{20} W/cm^2 are becoming common, and the generation of γ-rays, x-ray/ultraviolet (XUV) radiation, and fusion neutrons has been reported. Now, antimatter in the form of positrons has been observed by researchers from the Max-Planck-Institute for Quantum Optics in Garching, Germany, and the Lund Institute of Technology in Sweden. In the October 23 issue of *Applied Physics Letters*, they report the production of 10^6 positrons (e^+) per laser pulse, with a mean energy of approximately 2 MeV. The maximum intensity of this new source is estimated to be equivalent to 2×10^8 Bq. Although positron generation has been reported in experiments at Lawrence Livermore National Laboratory using the petawatt laser source, this is the first report of such phenomena produced with a tabletop system.

By focusing 790-nm wavelength laser pulses of 130-fs duration and 220 mJ pulse energy from the ATLAS laser facility at the Max-Planck-Institute onto a helium gas jet, a beam of fast, multi-MeV electrons was generated. Electron-positron pairs were produced by directing this beam onto a 2-mm-thick slab of Pb, which served as a high-Z converter. Known mechanisms for such conversions include Bremsstrahlung photon processes and electron-nucleus collisions. Preliminary calculations carried out by the investigators indicated that the indirect Bremsstrahlung process should dominate, and that given a 2-mm-thick Pb converter and 3-MeV electrons, a fraction of 10^{-3} should be converted into positrons.

The primary electrons emerging from the gas jet were collimated by passing through a 1-cm-diameter hole in a plastic block. The Pb converter disk was placed inside this hole, at a distance of 16 cm from the helium-gas jet. Upon exiting the converter, the electron-positron pairs were separated by a 150-mT magnetic field; the positrons were detected by a light-tight, 1.5-cm-thick plastic scintillator coupled to a photomultiplier tube.

Two types of measurements were taken: one with the path of the positrons to the scintillator blocked (to measure only the background signal), and one with the path open (measuring both background plus positron signal). The difference between these measurements accounts for the positron contribution only. In the 2 ± 0.08 MeV channel, 30 ± 14 positrons on average were detected per laser pulse, comparing favorably with the calculated average of approximately 25 positrons per pulse. After scaling this over the full energy range and the entire solid angle, the researchers infer a value of 10^6 positrons per pulse. Further scaling this result to the full uncollimated elec-

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tron beam gives a rate of ~2×10^8 positrons per second.

The investigators see possible applications in positron-annihilation and Doppler-broadening spectroscopy, as well as positronium spectroscopy.

TIM PALUCKA

Scanning Calorimetry Technique Extended to Nanoliter-Scale Samples

Conventional differential scanning calorimetry (DSC), a technique for measuring heat exchange during chemical reactions or phase transformations, is limited to milliliter-sized, macroscopic samples. However, a team of researchers in the Materials Department at the University of Illinois at Urbana-Champaign fabricated a calorimeter for use with solid and liquid samples possessing volumes of the order of a few nanoliters. The calorimeter consists of a 0.3-µm-thick silicon nitride membrane on a silicon frame. A small "box" (volume ~35 nL) is on one side of the membrane, and a nickel heating line is on the other. In the October 23 issue of *Applied Physics Letters*, L.H. Allen, E.A. Olson, S. Lai, J.T. Warren, and co-workers report the test outcome of their "biobox" nanocalorimeter, which was fabricated at the Cornell Nanofabrication Facility. For both indium and water-droplet specimens, they demonstrated excellent agreement between both measured melting point and heat of vaporization values and the accepted values.

Calorimeter performance was evaluated in scanning and heat-conductive modes for liquid and solid samples. In the scanning mode (100–150 K/s), the melting point of a 52 nL indium specimen and the heat of vaporization of water droplets (2–100 mL) were determined by heat-capacity measurements. The results demonstrate that, in this mode, the system operates with a temperature sensitivity of ±0.1 K and power sensitivity of ±7 µW. In the heat-conductive mode, which is especially useful for processes that occur near room temperature, a ~60 nL water droplet was placed in the calorimeter, and the system temperature was monitored as the droplet evaporated. The experimental heat of vaporization fell within 25% of the predicted value, and the system's temperature and power sensitivity were shown to be ±13 mK and ±3 µW, respectively.

According to Allen, with the extension of calorimetry to nanoliter-scale materials, scientists may be able to gain insight into the thermodynamics and kinetics of biological processes and nanoscale materials, areas in which recent interest has soared. Fields in which nanocalorimetry may find application include the biological sciences in studies of basic cell processes and the microelectronics industry in studies involving individual flip-chip solder balls.

"Amazing things happen when the size of the matter is on the nanometer scale—for example, the melting point dramatically decreases," said Allen. Using the new nanocalorimetry device, Zhang, Kwan, Wisleder, and co-workers report in the October 15 issue of *Physical Review B* that when the size of indium particles is of the order of a few thousand atoms, they melt at room temperature. "Even more amaz-

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