Gaussian profile produces rounded edges on apertures with small sizes and the structure becomes contaminated with gallium ions. To overcome these problems, J.B. Leen, P. Hansen, Y.-T. Cheng, and L. Hesselink from Stanford University have proposed a method of fabricating apertures by milling the metal through a silicon nitride membrane that allows long milling times that polish the metal sidewalls, and reduces the gallium contamination to negligible lateral depths, protecting in this way the metal layer from damaging gallium ions and beam tails. As reported in the December 1, 2008 issue of *Optics Letters* (DOI: 10.1364/OL.33.002827; p. 2827), the researchers compared C-apertures of various sizes fabricated with their new method of through-the-membrane milling (TMM) with apertures fabricated with conventional DMM, and simulated them by using realistic finite difference time domain (FDTD) modeling that includes rounding, gallium contamination, and metal surface roughness.

The researchers milled C-apertures in a 75-nm thick silicon nitride membrane onto which a 100-nm thick layer of gold and a 6-nm chrome sticking layer were sputtered. Apertures were produced by milling for ~3 s from the metal side (DMM) or for ~30 s from the nitride side (TMM), using a FIB operating at 30 keV and 1 pA beam current. The researchers observed that the tongue of the DMM aperture was heavily eroded by the tails of the FIB, and gallium contamination could be easily seen in and around the aperture, making it nearly useless for applications in optical data storage. On the other hand, TMM apertures were well formed, with the metal surface untouched by damaging gallium ions.

Simulation showed that the TMM aperture's near-field spot was 2.2 times smaller and 63 times more intense than the DMM aperture and that the primary effects of extending the aperture channel into the silicon nitride are to shift the resonant aperture size to larger values and to increase transmission by about 100%, both due to the lower refractive index at the aperture entrance.

The researchers verified the simulation by measuring far-field optical transmission and observed a strong resonance of the TMM apertures, 8.8 times more intense than that of the DMM aperture transmission peak, which implied a good agreement with simulations.

The researchers have simulated, fabricated, and tested a new method of creating high-quality near-IR regime near-field apertures in thin metal films and they said that the preservation of fine features at the metal surface and the protection from gallium contamination that the TMM technique provides is useful in the fabrication of several optical near-field structures including bow-tie and fractal apertures, periodic arrays, and gratings.

JOAN J. CARVAJAL

Nanoporous Carbon Membranes Characterized for Biological Use

Nanoporous membranes may serve as interfaces between implantable biosensors, immunoisolation devices, or drug delivery devices in biological environments. Once implanted within the body, medical device function may be inhibited by the adsorption of cells and proteins in a process known as biofouling. Currently, hydrogels, phospholipids, and other organic materials have been used to modify the tissue-medical device interface and reduce adsorption. An ideal tissue-medical device interface would be thin and highly porous in order to allow the medical device to quickly detect changes in the surrounding environment. Now researchers have proposed the use of diamond-like carbon (DLC)-coated nanoporous alumina for a biosensor membrane.

As reported in the August 8, 2008 issue of *Biomedical Materials* (DOI: 10.1088/1748-6041/3/3/034107), R.J. Narayan of the University of North Carolina (UNC), Chapel Hill; N.A. Monteiro-Riviere of UNC and North Carolina State University; R. Crombez of Eastern Michigan University; and their colleagues have analyzed coated alumina membranes for morphology, mechanical strength, and biocompatibility of DLC-coated alumina membranes. To prepare the membranes, researchers used the ultraviolet pulsed laser deposition technique to deposit thin films of diamond-like carbon, gold, and titanium on nanoporous alumina membranes (pore size = 100 nm) at 25°C for 2 min. The surface properties were characterized using a Nanoscope IIIa scanning probe microscope and the mechanical properties were determined using the Nano-indenter XP system. Cell viability was determined by incubating the membranes in a human epidermal keratinocyte culture and evaluating mitochondrial activity.

Imaging revealed a smooth surface containing a high number of pores that were also monodisperse in appearance on the DLC membranes. Additionally, by changing the parameters of the deposition process, such as electric field strength and processing temperature, the size of the pore can be altered. A comparison of the uncoated alumina membranes and the DLC membranes showed that the DLC membranes had a lower hardness value and Young's modulus, attributed to the larger pore sizes of the DLC membrane. The 24-h MTT assay demonstrated the human epidermal keratinocyte cell viability was highest in the uncoated membranes; and that the viability of the DLC-coated membrane was significantly higher than that of the gold- and titanium-coated membranes. The researchers said that the diamond-like carbon-coated membranes have potential use in a large number of medical applications.

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