Fabrication of high density, high-aspect-ratio polyimide nanofilters

Olga V Makarova, Cha-Mei Tang, and Platte Amstutz
Creatv MicroTech inc., 2242 West Harrison St., Chicago IL 60612

Mark Hoffbauer and Todd Williamson
Los Alamos National Laboratory, Los Alamos, NM 87545

Ralu Divan and Alexandra Imre
Argonne National Laboratory, 9700 South Cass Av., Argonne IL 60439

Nanofilters have a wide range of applications in many fields, including medical diagnostics, drug delivery, and hemodialysis. Some issues that limit commercial application of current nanofilters in medicine are low pore density, non-uniform pore size, and the use of materials that are not biocompatible. Here we report a novel method for fabricating high porosity polymer nanofilters that have smooth, uniform and straight pores with high aspect ratios. Aspect ratios of 40 or more have been achieved. Pore size, density, and shape can be predetermined with a high degree of precision.

The method combines energetic neutral atom beam lithography/epitaxy (ENABLE) [1] and e-beam lithography. This technology allows etching polymeric materials at low temperature in a clean, well-controlled, and charge-free environment, making it very suitable for fabricating nanofilters and other components for biomedical applications. The filters were fabricated using commercially available polyimide films of 25 μm and 7.5 μm thickness. The films were spin coated with negative resist and patterned using a Raith 150 e-beam lithography system. The pattern had a 400 nm periodic array of 200-nm-diameter circular openings. Metal sputtering and lift-off were performed to form a hard mask on the film surface. The polyimide was then etched through the metal mask using the ENABLE technique.

Figures 1 and 2 show the preliminary results for patterning 25 μm thick polyimide films. We performed focused ion beam cross-sectioning with an FEI Nova NanoLab microscope to determine the depth of the etched channels. The results show that etching high aspect ratio nanopores in polymeric materials can be readily achieved.

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1. E. A. Akhadov, D. E. Read, A. H. Mueller, J. Murray, and M. A. Hoffbauer, *J. Vac. Sci.Technol.* B 23 (6), 3116–3119 (2005)

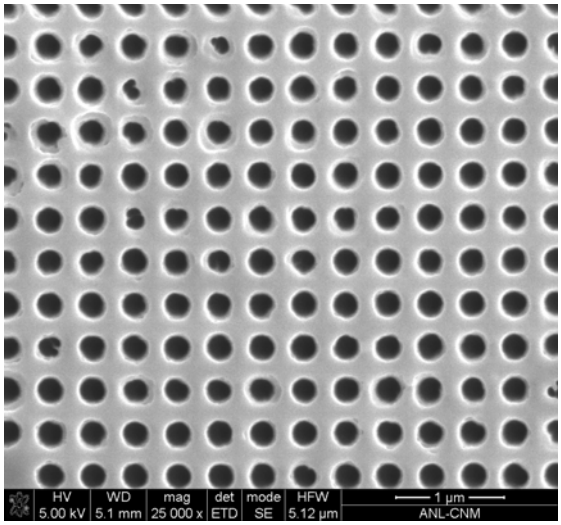

Figure 1. SEM image of a polyimide film filter with 200 nm pores and 400 nm periodicity.

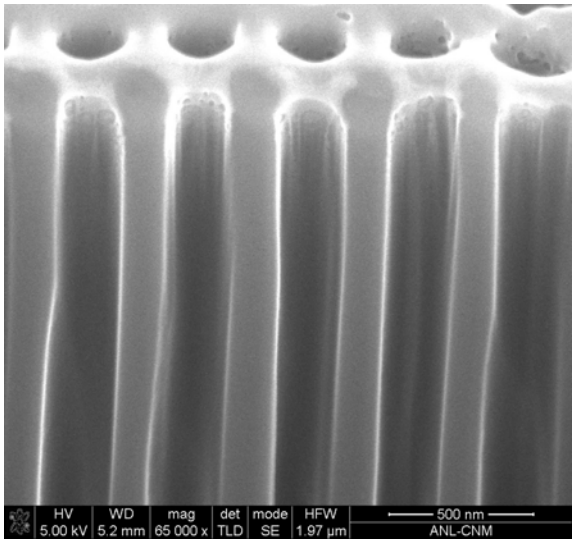

Figure 2. Cross-sectional SEM images of a processed polyimide film. Focused ion beam milling was used to cut the filter at the 90^{o} angle.