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

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MOTIVATION
Nanofilters have a wide range of applications in many fields, including medical diagnostics, drug delivery, separation technology, size screening, nano-stamps, etc. Common commercial nanofilters are in the form of glass fibers and cellulose membranes, but they have non-uniform pore size and not straight pores. Nuclear track etched nanopores and anodically oxidized alumina can have uniform and straight pores, but nuclear track etched nanopores have low pore density and anodically oxidized alumina is not biocompatible. Here we report a novel method for fabricating very high porosity polymer nanofilters that have smooth, uniform and straight pores with high aspect ratios. Pore size, density, and shape can be predetermined with a high degree of precision.

Energetic Neutral Atom Beam Lithography/Epitaxy (ENABLE) utilizes a proprietary source to produce a collimated beam of neutral oxygen and nitrogen atoms with kinetic energies of a few electron volts and simultaneously delivers a very large flux of these energetic atoms to a substrate (flux ~ 10^5 larger than other energetic neutral O- or N-atom sources). Due to the inherent properties of the oxygen atom beam (charge neutrality, directionality, and ~98% atomic content) and the very direct chemistry involving the interaction of the oxygen atoms with polymer surfaces, reproduction of mask features into polymeric films takes place without significant undercutting or tapering effects. Suitable polymer materials must contain no metal (e.g., PMMA, polyimide, polycarbonate, polyethylene). The surface is first patterned with a mask material, such as metal or SiO_2, that does not react with energetic oxygen atoms to form volatile products.

METHOD
E-beam Lithography

Pore Formation
ENABLE

RESULTS

CONCLUSIONS

We have demonstrated the method for fabrication of nanopores in a biocompatible polyimide material. High density, high-aspect-ratio uniform channels were produced.

A reusable etching mask can eliminate the costly and laborious e-beam writing for each filter and to allow large scale, rapid production of polymer nanofilters. We plan to use 7.5-µm-thick Cr coated Kapton® filter as a mask for etching holes in polymer material.