FABRICATION OF THIN FILMS WITH NANOSTRUCTURED HELICAL PORES USING TEMPLATING OF GLAD FILMS

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Macroporous films (films having pores with dimensions of greater than 50nm) are of interest for a variety of applications, including optical devices, mechanical systems, filters and sensors. We have developed techniques to fabricate macroporous metal and polymer films in which the pores have a helical structure, as shown in figure 1. These perforated thin films (PTFs) are fabricated using a templating process in which a thin film deposited by glancing angle deposition (GLAD) is used as the master. Good control over the pore shape, spacing, and density can be achieved by modifying the deposition parameters.

GLAD is a physical vapor deposition process in which the substrate is held at an oblique angle (70^o – 89^o) with respect to the vapor source [1, 2]. E-beam or thermal evaporation is used to generate a collimated beam of vapor flux, and a combination of shadowing and limited adatom diffusion results in the growth of porous films with independent, high aspect ratio nanostructures. The direction of growth of these structures tracks the general direction of the source, and controlled substrate motion can be used in order to create films with engineered nanostructures. If the substrate is rotated continuously during the deposition process, the resulting structures will be helical in shape, where the pitch and handedness of the helices are determined by the speed and direction of rotation. The density, spacing, and diameters of these helical structures are dependent on both the source material and deposition angle [3]. Typical cross-sectional diameters range from 50nm – 150nm. The structure of the GLAD film determines the shape and size of the pores produced in subsequent processing.

We have developed an electroplating process for making metal PTFs. In this process a SiO_2 GLAD film is deposited on top of a thin layer of metal that acts as a cathode during electrodeposition. Nickel or gold is plated into the GLAD film until it covers the top of the helices. This material is then etched back in order to expose the top of the glass film, which is subsequently removed using wet-etching. A nickel PTF is shown in figure 1(a). The pores of the metal film closely resemble the helices of the original GLAD film.

Polymer PTFs can be made by filling a GLAD template with a polymer, etching it back to allow access to the GLAD template and then removing it in a wet-etch process. An example of a helical polymer PTF is shown in figure 1(b). Photoresist helical PTFs have been previously shown to be optically active, where the optical activity is up to 3 times as strong as the films from which they were templated [4]. We are working to characterize the mechanical and optical properties of polymer helical PTFs.

In this presentation we will review the fabrication processes that can be used to make perforated thin films, including an overview of the GLAD process, and describe the results of our work in characterizing these materials.

Figures:

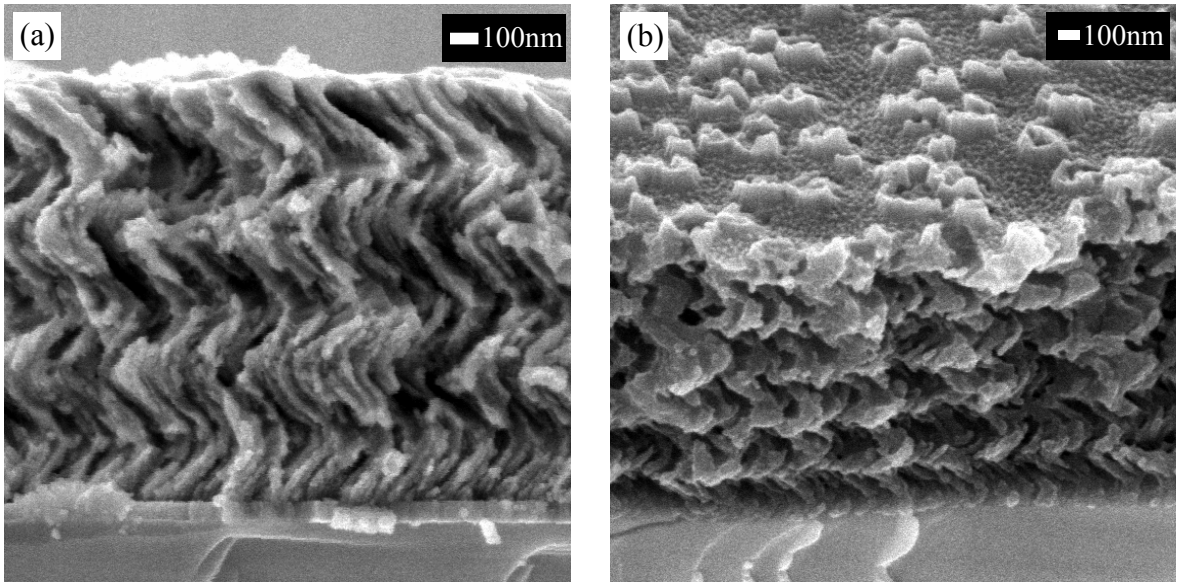

Figure 1: A nickel PTF was made from a GLAD template film consisting of a 3-turn helix (shown in cross-section, a). A polymer PTF was made from a 6-turn GLAD film (b).

References:

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