NANOIMPRINT TECHNOLOGY: RECENT PROGRESS AND APPLICATIONS

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Nanoimprint Lithography (NIL) has emerged as a promising nanopatterning technology in recent years. NIL uses a hard mold to mechanically deform the polymer resist material to create nanoscale patterns, which *completely free itself from the resolution-limiting factors such as light diffraction or beam scattering* that are often inherent with other more traditional approaches. Our recent work have shown that it can be extended to patterning on flexible substrate, on topographies, as well as forming 3D polymer nanostructures via a reverse imprinting process (Fig. 1). By combining the nanoimprint approach with conventional photography, we developed a new technique that can pattern various feature sizes in a single step and simplify the process significantly (Fig. 2). The nanoimprint technique not only has the ability to pattern precise nanoscale features, it is also compatible with polymer material processing. Based on these characteristics, we have applied nanoimprinting to several polymer based photonic devices, including nanostructures in nonlinear optical polymers, high-resolution OLED pixels, and polymer waveguide devices. For the latter devices, we will discuss a specific type, namely polymer micro-ring resonators, fabricated by a direct imprinting technique (Fig. 3), and its new application for biochemical sensing.

Based on the principle of NIL, we have also developed a new approach to fabricate nanofluidic channels with well controlled dimensions, and have studied the behavior of DNA molecules in such confinement channels. The nanochannels were fabricated by imprinting a channel template into a thin polymer film cast on a glass cover slip in a *single* step (Fig. 4), offering a much higher throughput than previous methods. It is easy to control the nanochannel dimensions by a simple relationship involving the initial polymer layer thickness and the mold pattern configuration. We demonstrated effective DNA stretching in these nanochannels, which could lead to applications of quick mapping of genomic DNA segments in short time using very small amount of DNA samples. This method provides a simple and practical solution for low-cost fabrication of nanofluidic channels, which may serve as a useful tool for chemical analysis system in the nanoscale.

In addition, we will describe the application of the nanoimprinting in nanoscale protein patterning. The ability to selectively localize proteins to patterns or specific locations is important for development of biosensors, bioMEMS, and basic proteomic research. We will present a flexible technique for selectively patterning bioactive proteins with nanoscale resolution using nanoimprinting and surface functionalization. We have successfully created protein patterns with sub-100 nm resolution (Fig. 5), and have demonstrated that the biological functionality of patterned target proteins is retained by using antibody experiment. Much of the work that will be presented can be found in a recent review article [1].

References:

[1] L. J. Guo, Topical Review, J. Phys. D: Appl. Phys, **37** (2004) R123.

Figures:

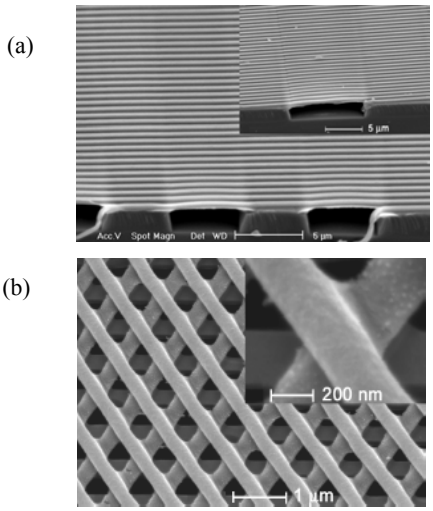

Fig. 1. ***SEM pictures of (a) reverse imprinted polymer gratings on topography, and (b) a 3-layer polymer nanostructure.***

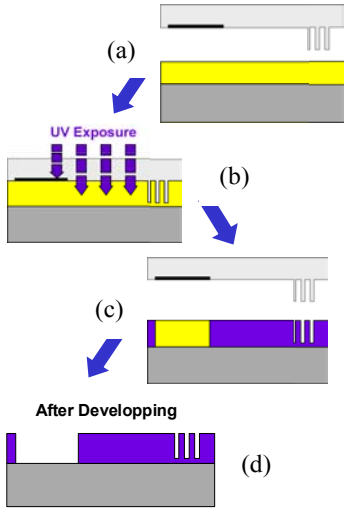

Fig. 2. ***Schematic of combined nanoimprint and photolithography technique using a hybrid mould.***

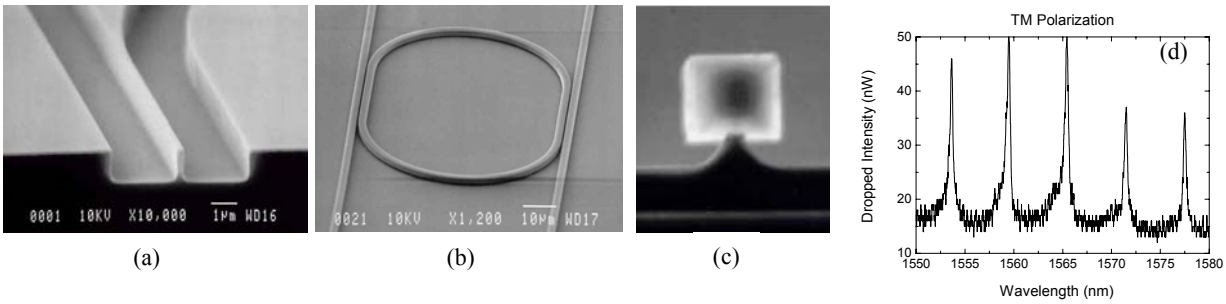

Fig. 3. ***SEM pictures of (a) SiO_2 mold used to replicate the polymer waveguides. (b) & (C) Perspective view and cross-sectional view of polymer micro-ring resonator fabricated by direct imprinting method. (d) Optical spectrum measured from the drop port of a microring resonator.***

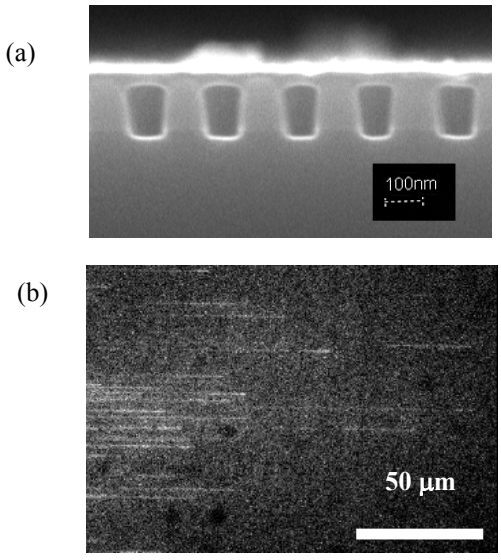

Fig. 4. ***(a) SEM micrograph of imprinted nanofluidic channels with cross sections of 75 by 120 nm. (b) Fluorescent images showing the stretching of 103 kb long T5 phage DNA in the nanochannels that reaches about 95%.***

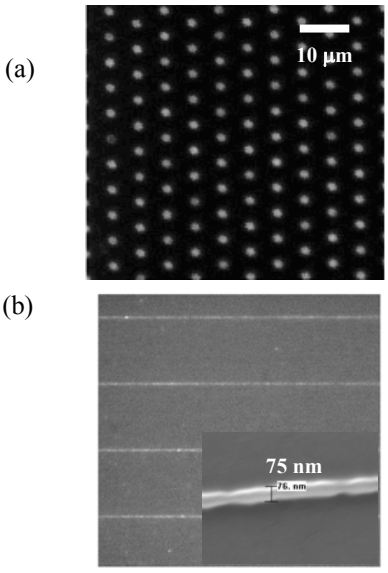

Fig. 5. ***Fluorescence image of (a) rhodamine-labeled streptavidin bound to uniform microscale dots of biotinylated BSA protein on oxide, and (b) biotinylated BSA bound to the 75nm wide-lines pattern (insert: SEM of the nanoline patterns).***