

# Molecularly selective nanopatterns using nanoimprint lithography: a label-free sensor architecture

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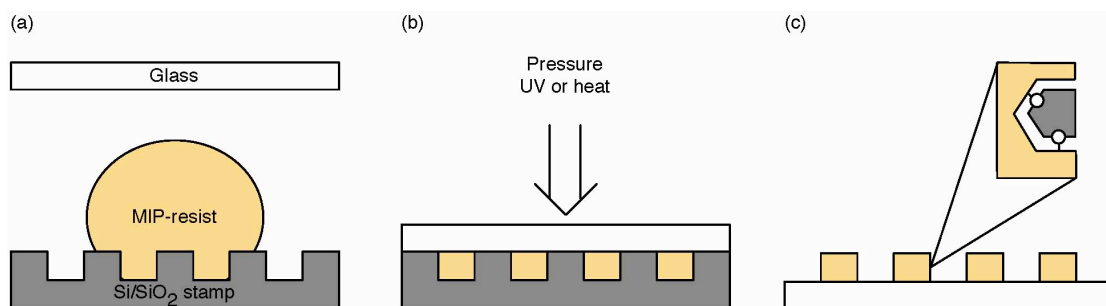
Besides generating small physical sizes, the present “top-down” fabrication methods, such as nanoimprint lithography (NIL), are unable to create rationally designed molecular recognition sites for molecular sensing applications. But, the “bottom-up” approach used in synthetic chemistry can assemble molecules and atoms precisely into various nanomaterials (e.g. organic colloids, lipid vesicles, micelles), but is difficult to create patterned structures with a long range order.

One intense research area is the development of chemical and biochemical sensors based on micro- and nano-mechanical transducers.<sup>1</sup> But to enable target selectivity, it is necessary to introduce well-defined molecular recognition components into the nanostructures. Molecular imprinting is a very powerful approach for preparation of synthetic polymers having pre-designed molecular recognition properties. This approach uses molecular template to create binding sites in cross-linked polymers by means of free radical polymerization reactions.<sup>2</sup> Due to their extraordinary stability and ease of preparation, molecularly imprinted polymers (MIPs) have attracted great interest, particularly for separation of difficult chemical compounds and development of robust chemical sensors. Until now, it has been impossible to fabricate, in one single step, nanostructures containing molecular recognition sites using NIL. One of the reasons is that many biologically derived recognition components, e.g. antibodies are not stable under the processing conditions used in NIL (e.g. high temperature, use of organic solvents, etc.).

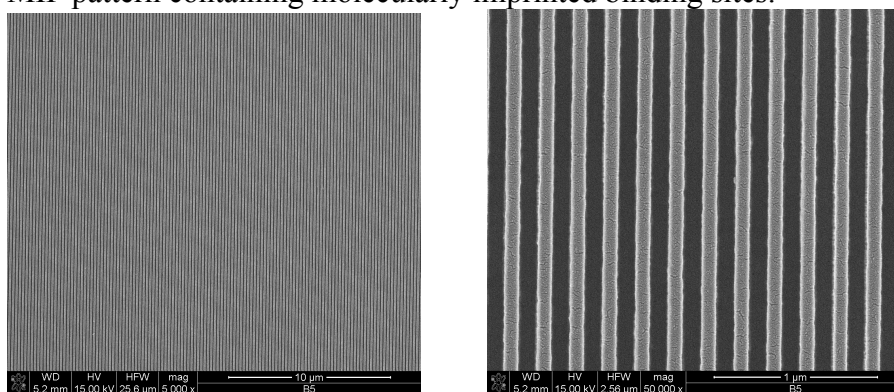
In this work we have for the first time introduced molecular selectivity into nanostructured polymers by combining nanoimprint lithography with molecular imprinting technique. The simultaneous imprinting on two length scales (nano and ångström) made it possible to generate highly specific molecular recognition sites in nanopatterned polymers with feature size down to 100 nm. (Fig 1-3). We demonstrate that the patterned structures are able to distinguish different enantiomers of small organic molecules at a concentration as low as 246 pM.

(1) Ghatnekar-Nilsson, S.; Karlsson, I.; Kvennefors, A.; Luo, G.; Zela, V.; Arlelid, M.; Parker, T.; Montelius, L.; Litwin, A. *Nanotechnology* 2009, 20, 175502 (6pp).

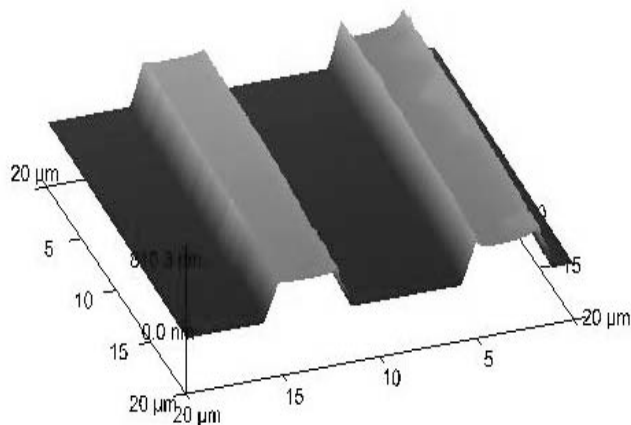
(2) Ye, L.; Mosbach, K. *Chem. Mater.* 2008, 20, 859–868.



*Figure 1:* Patterning MIP nanostructures using reactive NIL. (a) A monomer mixture containing the molecular template is deposited on a patterned stamp. (b) A substrate is pressed against the stamp, causing the reaction mixture to fill up the empty space defined by the stamp pattern. The monomers are polymerized by UV or thermal polymerization. (c) Releasing the stamp (de-molding) furnishes a MIP pattern containing molecularly imprinted binding sites.



*Figure 2* SEM images of a patterned MIP fabricated by reactive NIL using UV initiated polymerization. The scale bar corresponds to 10 µm in (a) and 1 µm in (b).



*Figure 3* AFM image of a MIP pattern generated by UV initiated polymerization. The stamp used was patterned as 5 µm × 500 nm stripes separated by 4 µm space.