A Molecule Trapping and SERS Sensing Device by 3-D Nanoimprint

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Nanoimprint lithography (NIL)[1] is a cost-effective nano-patterning technology based on the mechanical deformation of a resist. During the process, 3-D information of the mold are transferred to the resist, in contrast, most other lithography technologies only transfer 2D information to the resist. We developed a process to fabricate high-aspect-ratio 3-D nanostructures using nanoimprint lithography.[2] For example, we reported the fabrication of nano-cones with height up to 2 μm and tip diameter less than 15 nm[2] last year. We also fabricated nano-pillar array with 100 nm in diameter and 750 nm in height[3] (Figure 1c).

We demonstrated a molecule trapping and sensing device based on the nano-pillar array[3]. Tips of the nano-pillars were coated with gold. The working schematics are shown is figure 1a&b). The solution to be detected was first dropped onto the sample. Then the pillar tips were closed under the capillary force (figure 1d), while the solvent evaporated. During this process, dissolved molecules were trapped in the gaps between tips, and SERS hot spots (SERS enhancement factor of $2x10^{10}$) also formed in the same places. The molecule trapping effect is shown in figure 2 with a benchmark molecule *trans*-1,2-bis(4-pyridyl)ethylene (BPE). That provides a great platform for low concentration molecule detection.

The 3D NIL process provides a cost-effective method for mass production of such SERS substrates reliably and deterministically for sensor applications, and opens a path toward the future integration of such SERS substrates with optical elements as well as MEMS components.

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J. Am. Chem. Soc., 2010, *132* (37), pp 12820–12822

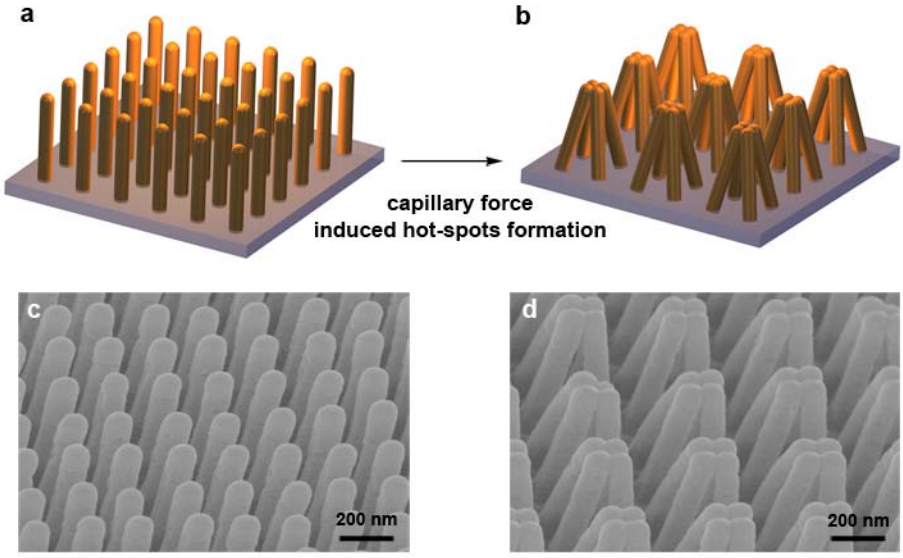

Figure 1 (a) and (b) the schematic of the molecular trap. The nano-pillar tips are closed under the capillary force, and the molecules are trapped at the SERS hot spots. (c) An SEM image of nano-pillars with 100 nm in diameter and 750 in height fabricated using nanoimprint. (d) An SEM image of nano-pillars with closed tips and trapped molecules.

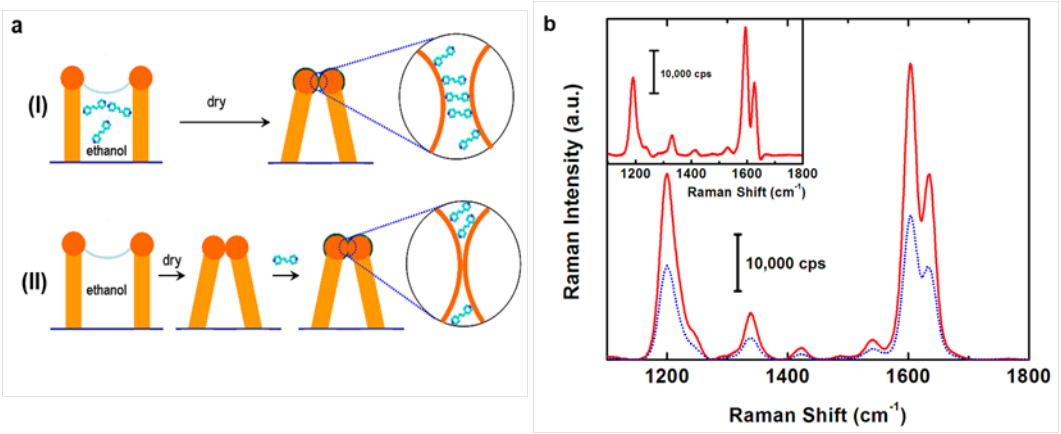

Figure 2**.** Demonstration that molecules were trapped in the fingertips. (a) Schematic illustrations: (I) fingers immersed in analyte solution and dried to close the fingers and (II) fingers immersed in pure ethanol to close the fingers prior to exposure to analyte solution. The insets show the presumed details at the fingertips for both cases. (b) Comparison of Raman spectra of the analyte molecules from case I (red spectrum) and case II (blue spectrum). The inset shows the difference spectrum of the red and the blue spectra, indicating the net contribution from the molecules trapped in the fingertips.