Fiber-facet SERS Probes Fabricated Using Double-Transfer Nanoimprint Lithography

Shijie Li, Zhouyang Zhu, and Wen-Di Li*

Department of Mechanical Engineering, Univ. of Hong Kong, Hong Kong, China

*liwd@hku.hk

Optical fiber based surface enhanced Raman scattering (SERS) sensors have potentials in remote and weak signal detection in various applications, e.g. air/water pollution monitoring, explosive detection and biomarker detection. Fabricating metal nanostructures with surface plasmon resonance (SPR) in excitation wavelength range on fiber facet is important to enhance Raman signals.[1] Periodic nanostructures contribute to controllable 'hot spot' distribution compared with self-assembly nanoparticle method. For periodic nanostructures fabrication, nanoimprint lithography has advantages of low cost and high throughput, compared with focused ion beam, interference lithography and other conventional methods[2].

In this work, we use double transfer UV-NIL [3] to transfer metal nanostructures from a cyclic olefin copolymer (COC) mold to the fiber facet. COC is used as the NIL mold substrate material for its low cost, low surface energy, chemical inertness and transparency.[4] Once a COC mold carrying pillar or hole arrays is fabricated by thermal embossing, gold or silver is deposited on it by thermal or e-beam evaporation. Then the metal nanostructure is transferred onto fiber facet by cross-linked UV-cured resist, as shown in Fig.1. The transferred metallic nanostructures feature closely spaced double layers of disks and holes and the electric field is enhanced in the space between the metal disk and hole. The electric field distribution and its enhancement of this structure are estimated in FDTD simulation. We also compared the effect of different configurations and geometric parameters of the disk-hole coupled structures to further improve the device performance.

Fig.2 shows the fabricated SERS structures on a multi-mode fiber facet using the fabrication procedure shown in Fig.1. It shows the SERS-active metallic nanostructures covering the whole fiber facet with an underlying adhesive resist thickness of 10 um. In this demonstration, the gold thickness is 50 nm and the fabricated structure has a period of 500nm and a depth/height of 150nm.

The SERS performance of our fabricated SERS probes will be further characterized. Our results will provide a promising approach towards further improved portable fiber SERS sensors.

1. Gu, C., et al. *Recent advance in fiber SERS sensors*. 2008.
2. Yang, X., et al., *Nanopillar array on a fiber facet for highly sensitive surface-enhanced Raman scattering.* Optics express, 2012. **20**(22): p. 24819-24826.
3. Shen, Y., et al., *Double transfer UV-curing nanoimprint lithography.* Nanotechnology, 2013. **24**(46): p. 465304.
4. Khan, A., et al., *Nanostructure transfer using cyclic olefin copolymer templates fabricated by thermal nanoimprint lithography.* Journal of Vacuum Science & Technology B, 2014. **32**(6): p. -.

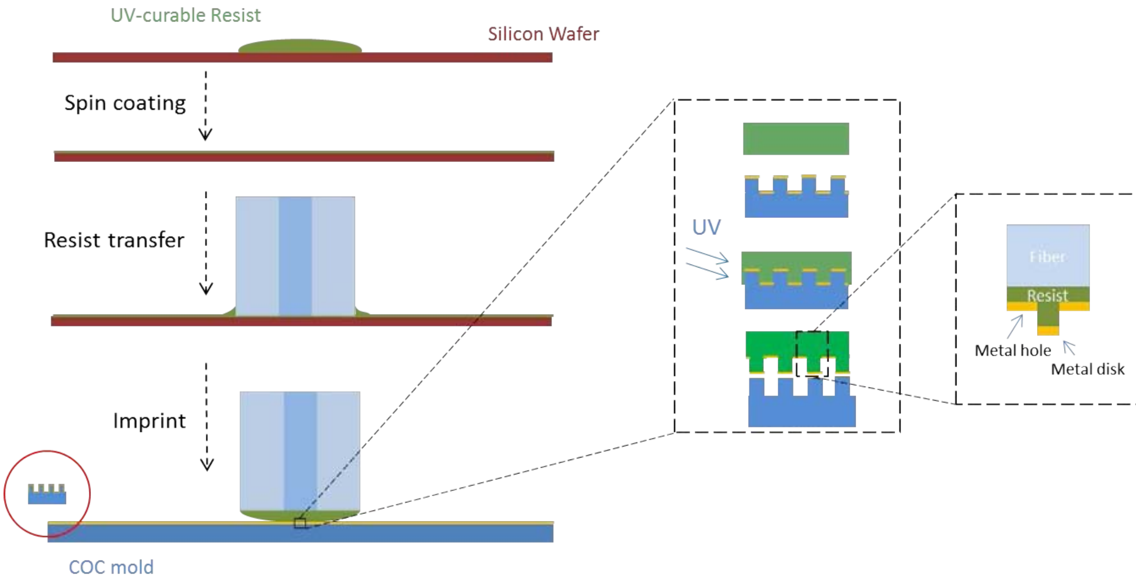

Fig.1 Schematic of double transfer UV-NIL on fiber facet

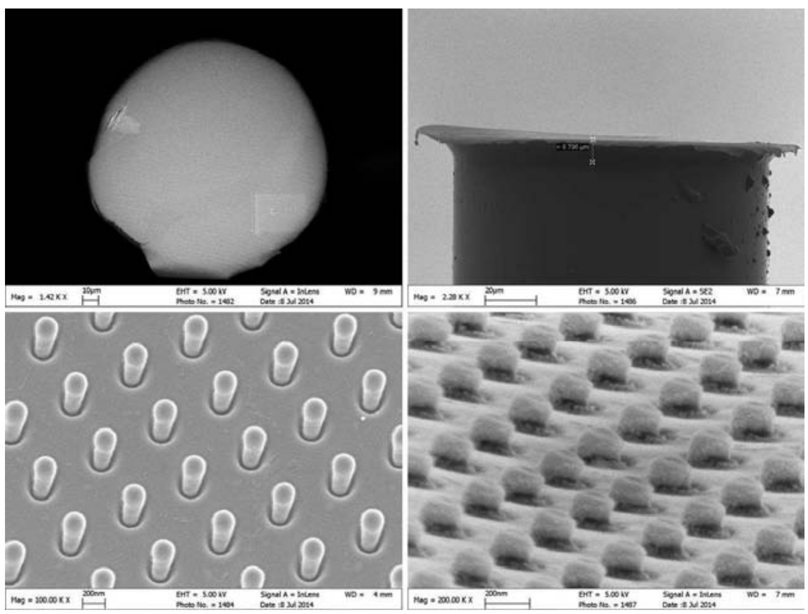

Fig.2 Transferred metallic pillar array on fiber facet