OPTICAL FIBER TIP FUNCTIONALIZED BY COLLOIDAL PHOTONIC CRYSTAL AND GOLD NANO-PARTICLES FOR SERS SENSING

Lucia Sansone[1], Marianna Pannico[2], Pellegrino Musto[2], Stefania Campopiano[3], Michele Giordano[1], Agostino Iadicicco[3,*]

1 Institute for Polymers, Composites and Biomaterials (IPCB), CNR, 80055 Portici, Italy
2 Institute for Polymers, Composites and Biomaterials (IPCB), CNR, 80078 Pozzuoli, Italy
3 Department of Engineering, University of Naples "Parthenope", 80143 Naples, Italy
**iadicicco@uniparthenope.it*

This paper presents a functionalized optical fiber tip for SERS sensing in optodre configuration. It consists in metal-dielectric colloidal crystals fabricated directly onto fiber optic tip by successive depositions of PS and Au nanoparticles.
Keywords: colloidal crystal, surface enhanced Raman-scattering

1. Introduction

This work explores metal-dielectric colloidal crystal (MDCC) structures as SERS sensing layer [1]. The MDCCs are fabricated directly onto optical fiber tip surface by successive depositions of PS Colloidal Crystal (CC) and Au NanoParticles [2]. The fiber device is explored as remote SERS probe in optrode configuration. The MDCC permits to combine localized surface plasmon resonance (LSPR) of noble metallic nanoparticles and photonic bandgap (PBG) of colloidal type photonic crystals (PhCs) [3]. For the sensing test, the fiber probes were immersed in a 100µM aqueous solution of Rhodamine (R6G). Then, preliminary SERS results were retrieved by a Labspec Aramis confocal Raman spectrometer.

2. Experimental results and discussion

For this work we selected a multimode optical fiber with core/cladding diameter of 105/125 µm and NA of 0.22. The probe fabrication consists in a 4-step procedure [2], (see figure 1(a)): 1) The optical fiber end is cut by standard fiber cleaver and cleaned with ultrapure water and ethanol; 2) Fiber tip surface was functionalized by a solution of APTES in ethanol at 5% for 3h; 3) The CCs on optical fiber tip were achieved by dip-coating vertical deposition technique from 0.1% w/w water solution of PS spheres: commercially available PS spheres with nominal diameter of 200 nm were selected; 4) Au-NPs on the fiber probe are added by dip-coating vertical deposition technique in Au-NPs water solution. Here the procedure is repeated 10 times in order to increases the number of Au-NPs on the fiber tip inside the porous structure provides from CC.

A Rhodamine 6G (R6G) aqueous solution was used as the standard sample to ascertain the SERS performances. The Raman spectra were collected by a commercial confocal Raman spectrometer (Labspec Aramis). In optrode configuration, the fiber SERS probe was cut into segments of 25 cm with a flat end surface for laser injection. The Raman spectra were collected through the 10x (NA=0.25) microscope objective, and 633 nm laser with the power of approximate 2 mW.

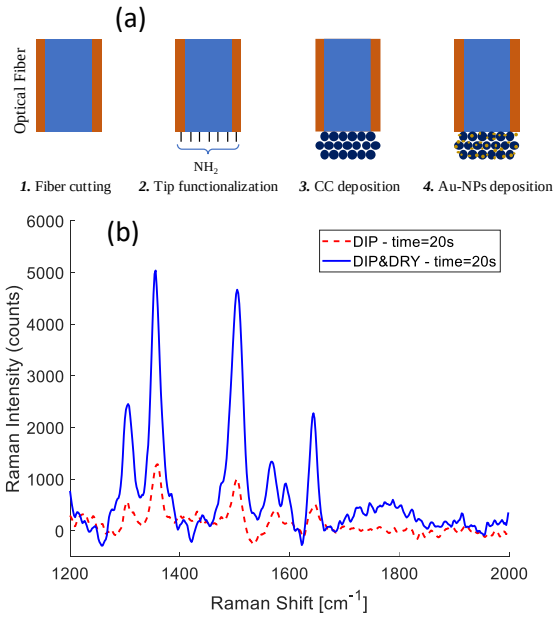

Fig. 1 (a) Scheme of the fabrication procedure; and (b) SERS spectra of R6G (100μM aqueous solution) collected in optrode configuration with acquisition time 20 s: DIP mode (dashed red trace) and DIP & DRY mode (solid blue trace).

The SERS spectra were collected in DIP mode (fiber probe surface was left in the 100μM R6G solution) and DIP & DRY mode (fiber tip was dried). All spectra with different exposure time are compared figure 1(b).

References

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