

Bessel Beam-Instigated Two-Fold SERS Enhancement in AuNP Structures Compare to Drop Casting

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1. Introduction

Since the discovery of SERS, due to its high sensitivity, it has been widely used in various fields such as biosensing, chemical sensing, and food safety etc., [1]. In SERS, when a probe molecule is placed near a metallic nanostructure it feels a localized field generated due to localized surface plasmons (LSPs) which effectively amplifies its Raman signal. The LSPs are the collective oscillation of free electrons in metallic nanostructures [2]. For the fabrication of the SERS active substrates various methods have been introduced to arrange the metallic nanoparticles (NPs) in specific morphologies and arrangements [3]. Optical forces of a laser beam can be employed to arrange metallic NPs efficiently on a substrate [4].

2. Results and discussions

In Fig.1(a-d), scanning electron microscope (SEM) image of the axicon tip, microscopic image of Bessel beam, SEM images of gold (Au) NPs dried with Bessel beam and without illumination of light are shown respectively. AuNPs dried with Bessel beam illumination are arranged in the Bessel beam rings, while AuNPs were drop cast and dried without illumination of light are agglomerated as can be seen from SEM images in Fig.1 (d). The Raman spectra has been recorded with a fiber optic Raman probe coupled to laser of excitation wavelength 785 nm. The recorded Raman spectra of R6G on coverslip is shown in Fig.2 (a) in a absence of AuNPs, in presence of AuNPs with Bessel beam

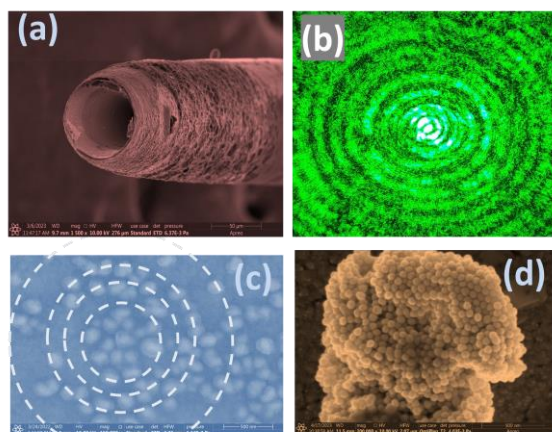


Fig.1. (a) SEM image of axicon tip, (b) microscopic image of Bessel beam, SEM image of AuNPs dried (c) with Bessel beam illumination, and (d) without illumination of light.

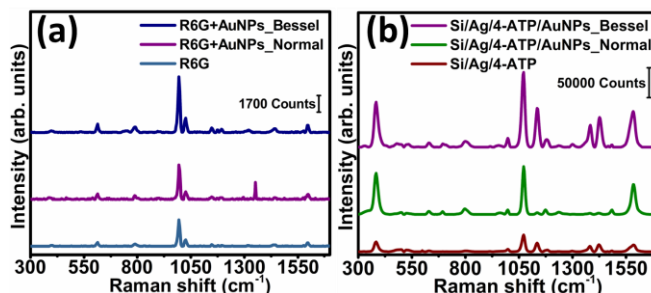


Fig.2. SERS spectra of (a) R6G in transmission mode (b) 4-ATP in reflection mode.

illumination and without illumination of light. It can be seen clearly from the figure that in presence of AuNPs, Raman signal enhances even if there is no illumination of light but the enhancement in Raman signal increases when we illuminate with Bessel beam. In Fig.2 (b), the Raman spectra recorded for 4-ATP molecule on reflecting substrate (Si/Ag substrate) is shown for Bessel beam illumination, without illumination of light and without AuNPs. It can be seen from the figure that there is more enhancement in Raman signal of 4-ATP molecule in case of Bessel beam illumination on reflecting substrate similar to transmitting substrate.

3. Conclusions

We have shown 2-fold enhancement in SERS signal of R6G and 4-ATP molecules on transmitting and reflecting substrates respectively with Bessel beam illumination as compared to without illumination of light (drop casting method).

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