Dynamic tuning SERS of silver interdigital nanogratings under external electric field

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Surface-enhanced Raman scattering(SERS) has attracted great attention owing to its great potential in the biochemical and single-molecule detection over the past decade. All kinds of SERS structures are widely explored [1-3]. However, active tuning SERS through external field is rarely reported so far [4]. In this work, we fabricate silver interdigital nanogratings structure to investigate tunable SERS spectra of p-thiocresol (C_7H_8S) under the external electric field. The effect of external electric field on the SERS spectra is demonstrated by different frequencies and field strength of alternating electric field. Field strength and frequency can affect SERS peak intensities through tuning different vibrational modes of C_7H_8S. This demonstration creates new opportunities for external dynamic tuning of SERS measurements.

Figure1 and 2 show schematic of fraction process for silver interdigital nanogratings structure and SERS measurement under electric field. Firstly, quartz substrate is coated with Cr (5nm) and Ag film (30nm) by electron beam evaporation. Next, electron beam lithography is used to fabricate the photoresist pattern of interdigital nanogratings on the sample. Finally, the interdigital nanograting structure is successfully transferred to metal film by Ar ion beam etching. Figure 3 give a SEM image of silver interdigital nanogratings structure, in which the period of nanogratings is about 200nm, the width of line is about 80nm. The area of interdigital nanogratings $20\times20\mu m^2$ is settled to ensure the isolation of adjacent lines. The SESR measurement results under electric field were showed on Fig.4, indicating that proper field strength and frequency can cause the resonance of specific vibrational mode of C_7H_8S, and thus it is possible to realize the dynamic tuning of SERS spectra through utilizing the external electric field. This knowledge may enable signal processing to selectively enhancement or suppress the spectra in future.

Acknowledgements This work was supported by National Natural Science Foundation of China (Grants No. 11174362, and 91023041) and the Knowledge Innovation Project of CAS (Grant No. KJCX2-EW-W02).

Reference:

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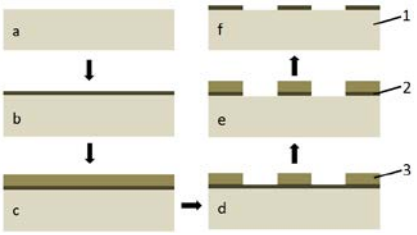

Figure 1. Procedure for fabricating interdigital gratings on the quartz substrate. a, cleaning the substrate; b, depositing Ag film; c, spin coating photoresist; d, fabricating the photoresist pattern by electron beam lithography; e, pattern transfer by ion beam etching; f, clearing the residual photoresist.1, quartz; 2, Ag film; 3, PMMA.

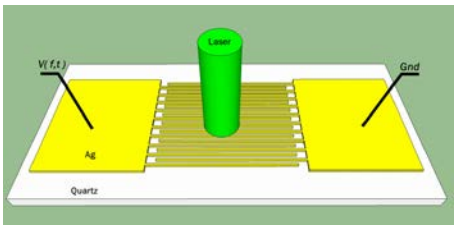

Figure 2. Schematic of interdigital gratings device and SERS measurement arrangement(not to scale).

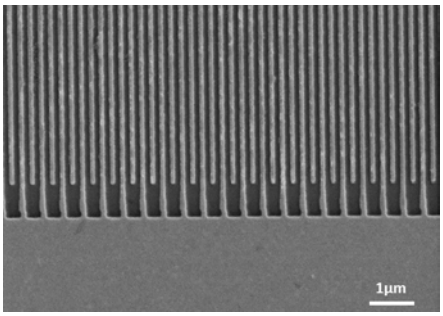

Figure 3. Scanning electron micrograph of Ag interdigital gratings and electrode.

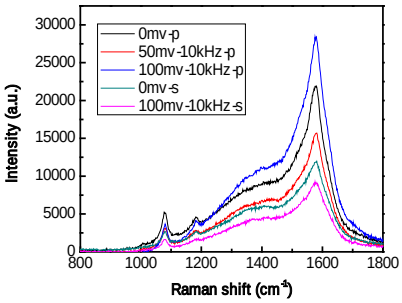

Figure 4. Raman spetra of p-thiocresol (C_7H_8S) on Ag gratings with external electric field. –p, the polarization orientation of laser is parallel to the direction of gratings; -s, the polarization orientation of laser is perpendicular to the direction of gratings.