Flexible SERS platform based on Ti₃C₂Tx-modified filter paper: preparation and SERS application: supplement

Rongyang Liu,¹ Li Jiang,¹,² Zizhen Yu,¹ Yi Chen,¹ Rui Xu,¹ and Shangzhong Jin¹,³

¹Department of Optical and Electronic Technology, China Jiliang University, Hangzhou 310018, China
²e-mail: lijiang@cjlu.edu.cn
³e-mail: jinsz@cjlu.edu.cn

This supplement published with The Optical Society on 8 September 2020 by The Authors under the terms of the Creative Commons Attribution 4.0 License in the format provided by the authors and unedited. Further distribution of this work must maintain attribution to the author(s) and the published article’s title, journal citation, and DOI.

Supplement DOI: https://doi.org/10.6084/m9.figshare.12746285

Parent Article DOI: https://doi.org/10.1364/AO.398454
Supplemental Material

Flexible SERS platform based on Ti$_3$C$_2$T$_x$ modified filter paper: preparation and SERS application

Rongyang Liu, Li Jiang*, Zizhen Yu, Yi Chen, Rui Xu, Shangzhong Jin*

Department of Optical and Electronic Technology, China Jiliang University, Hangzhou, 310018, China
*Corresponding author: lijiang@cjlu.edu.cn

Supporting Information 1

Fig. S1 SEM of Ti$_3$C$_2$T$_x$ modified filter paper (a) and bare filter paper (b). The morphology of cellulose is not obvious after Ti$_3$C$_2$T$_x$ adsorbed on the surface of filter paper.
Supporting Information 2

Calculation of enhancement factor (EF):

The enhancement factor (EF) was evaluated by the formula:

\[ EF = \frac{I_{\text{SERS}}}{I_{\text{bulk}}} \times \frac{N_{\text{SERS}}}{N_{\text{bulk}}} \]

where \( I_{\text{SERS}} \) and \( I_{\text{bulk}} \) are the peak intensities of the same mode on Ti3C2Tx-paper substrate and the normal Raman spectra of the solid analyte, respectively. \( N_{\text{SERS}} \) and \( N_{\text{bulk}} \) are the number of analyte molecules under the laser beam area on Ti3C2Tx-paper and the solid sample, respectively. The volume of the solid sample was acquired with the laser spot area and the penetration depth of the laser, so \( N_{\text{bulk}} \) was estimated with the following equation:

\[ N_{\text{bulk}} = \frac{N_A \times A \times h \times \rho}{M} \]

where \( N_A \) is Avogadro's constant, \( A \) is the laser spot size, \( h \) is depth of laser penetration, for 532 nm laser is estimated as 0.265 um, \( \rho \) is the density of dye molecules solid.

In our experiment, \( N_{\text{SERS}} \) can be estimated by the follow equation when dye molecules saturation adsorption on the surface of the paper substrate, here the saturation adsorption of dye molecules was assumed for 10^{-5} M concentration.

\[ N_{\text{SERS}} = \frac{A}{\sigma} \]

where \( A \) is the laser spot size, \( \sigma \) is the surface area of a dye molecule.

\[ A = \pi R^2 \]

where \( R \) is the spot radius of focused laser

\[ R = \frac{1.22\lambda}{N_A} \]

\( \lambda \) is the wavelength of the incident laser, \( N_A \) is numerical aperture of the objective.

For 532 nm laser use 50× objective with numerical aperture of 0.5, \( A \) is calculated as 5.29 um² and 633 nm laser is 7.49 um². The detection of R6G with 532 nm under 50× objective with a numerical aperture of 0.5, the \( N_{\text{bulk}} \) was estimated as 2.31 ×10^{11}, \( N_{\text{SERS}} \) was 3.4 ×10^{6} for the peak at 1573 cm\(^{-1}\) and the EF can be estimated as 2.25×10^{4}. The EF of CV and MG molecules are estimated about 2.5×10^{4} and 5.98×10^{3} for the peaks at 1584 cm\(^{-1}\) and 1616 cm\(^{-1}\), respectively.