Highly sensitive 3D microfluidic SERS chips fabricated by femtosecond laser processing for real-time Raman sensing

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Abstract: The highly-sensitive, real-time sensing of a tiny amount of substances is urgently needed in special fields such as environmental monitoring, medicine and so on. Surface-enhanced Raman scattering (SERS) based on extraordinary enhancement of electromagnetic field in the proximity of metal nanostructures can generate strong Raman scatting, which is an effective method for such a trace detection. We integrated a 3D glass microfluidic chip with a SERS sensor by all-femtosecond-laser-processing for real-time sensing of toxic substances. 2D periodic Cu-Ag nanostructure were generated inside the glass microfluidic chip as a SERS substrate by femtosecond laser induced periodic surface structure. By testing rhodamine 6G, we demonstrated the 3D SERS microfluidic chip was able to detect the substances with an enhancement factor larger than 10^7 and 8.8% relative standard deviation. Finally, the real-time SERS detection in microfluidic chips was successfully demonstrated by testing metal ions, which verified capability of the fabricated microchips as an excellent microfluidic SERS platform with ultrasensitive.

Keywords: nanostructure; microfluidic; SERS.

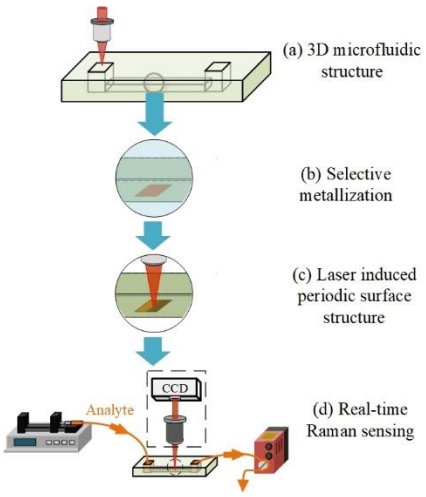

Fig. 1 Schematic of the fabrication procedure of SERS microfluidic chip using all-femtosecond-laser-processing. (a) Preparation of 3D microfluidic structures in glass; (b) Selective metallization in the fabricated glass microfluidic structure; (c) Nanostructure arrays fabricated using femtosecond laser induced periodic surface structure. (d) Real-time Raman sensing based on 3D SERS microfluidic chip.