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Fabrication of Flexible Surface-enhanced Raman-Active Nanostructured Substrates Using Soft-Lithography

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Over the recent years, surface enhanced Raman spectroscopy (SERS) has dramatically grown as a label-free detecting technique with the high level of selectivity and sensitivity. Conventional SERS-active nanostructured layers have been deposited or patterned on rigid substrates such as silicon wafers and glass slides. Such devices fabricated on a flexible platform may offer additional functionalities and potential applications. For example, flexible SERS-active substrates can be integrated into microfluidic diagnostic devices with round-shaped micro-channel, which has large surface area compared to the area of flat SERS-active substrates so that we may anticipate high sensitivity in a conformable device form. We demonstrate fabrication of flexible SERS-active nanostructured substrates based on soft-lithography for simple, low-cost processing. The SERS-active nanostructured substrates are fabricated using conventional Si fabrication process and inkjet printing methods. A Si mold is patterned by photolithography with an average height of 700 nm and an average pitch of 200 nm. Polydimethylsiloxane (PDMS), a mixture of Sylgard 184 elastomer and curing agnet (wt/wt = 10:1), is poured onto the mold that is coated with trichlorosilane for separating the PDMS easily from the mold. Then, the nano-pattern is transferred to the thin PDMS substrates. The soft lithographic methods enable the SERS-active nanostructured substrates to be repeatedly replicated. Silver layer is physically deposited on the PDMS. Then, gold nanoparticle (AuNP) inks are applied on the nanostructured PDMS using inkjet printer (Dimatix DMP 2831) to deposit AuNPs on the substrates. The characteristics of SERS-active substrates are measured; topology is provided by atomic force microscope (AFM, Park Systems XE-100) and Raman spectra are collected by Raman spectroscopy (Horiba LabRAM ARAMIS Spectrometer). We anticipate that the results may open up various possibilities of applying flexible platform to highly sensitive Raman detection.

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