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Fabrication of silver nano-protrusion based on silver sulfide solid electrolyte for surface-enhanced Raman spectroscopy

Silver (Ag) nanostructure surfaces are extensively used as substrates for surface-enhanced Raman spectroscopy (SERS) due to their characteristic surface plasmon resonance (SPR) throughout the visible, near-infrared, and infrared region. However, recent development for Ag-SERS substrates suffer from poor reproducibility, low performance, low stability and poor uniformity of SERS enhancement. Herein, a simple, low-cost and high-throughput synthesis method to construct the high-performance Ag nano-protrusion (NP) SERS substrate in a controllable manner has been developed. The SERS substrate derived from Ag nano-protrusions (NPs) is based on silver sulfide (Ag_2S) solid electrolytes which was synthesized via a wet chemical process. Ag NPs were fabricated by electron beam irradiation method. The highest density of Ag NPs as SERS substrate was found to be $2.2x10^8$ rods/cm^2. The SERS effect of methylene blue (MB) adsorbed on Ag/Ag_2S substrate has been investigated and a maximum enhancement factor (EF) of $1.9x10^3$ was achieved. This enhancement factor is 3-fold higher in magnitude than that of Ag film substrate without Ag NPs.

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