Hexagonally Ordered Arrays of Elliptical Silicon Nanowires Featured by Holographic Lithography for SERS Applications

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Surface-enhanced Raman scattering (SERS)—of which the enhancement depends on the type, size, roughness and shape of metal nanoparticles and the distance between them—is a powerful strategy for sensing applications.
Here, a novel, highly uniform and tunable hybrid SERS substrate has been achieved via prism holographic lithography (HL), ion-milling, catalytic wet-etching process, and electron-beam evaporation. The triply-split Au hole arrays, which can be fabricated using HL-featured structures as milling masks, act as the silicon (Si) wafer etching catalyst in a reaction solution to fabricate well-ordered silicon nanowire (SiNW) arrays. After removing the polymeric mask and metal thin film, the Au thick film is highly-anisotropically deposited on the hexagonally ordered triangularly coordinated elliptical SiNW arrays. This hybrid substrate shows tunable SERS activities according to the catalytic wet etching times causing different vertical gap distances. Moreover, highly intensified SERS signals can be achieved deriving from lateral interparticle coupling compared to the circular SiNW arrays with the good homogeneity.