High-density gold nanostar arrays on metal film for SERS chemical sensors

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Recently, a plasmonic system consisting of metal nanoparticles separated from a metal film by nanometer scale gaps have attracted great attentions as surface-enhanced Raman scattering (SERS) substrates since the uniform formation of precise gap regions between metal nanoparticles and films can provide reproducible hot spots with large SERS enhancements. Here we investigate the particle-film plasmon couplings of high-density gold nanostar arrays assembled on various substrates (silver, gold, silicon, glass). In particular, we show how the nanostar surface densities (or interparticle gap separations) affect the E-field enhancements from the particle-film plasmon couplings by analyzing the finite-difference time-domain (FDTD) calculation of E-fields and the experimental SERS intensities. Finally, we demonstrate optimally designed SERS substrates based on gold nanostars on metal films which can detect attomole level of target molecules.