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The Role of Localized and Propagating Surface Plasmons in Periodically-Arrayed Nanopillars

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Abstract Periodic arrays of plasmonic nanopillars have been shown to provide large, uniform surface-enhanced Raman scattering (SERS) enhancements. We show that these enhancements are the result of the combined impact of localized and propagating surface plasmon modes within the plasmonic architecture. Here, arrays of periodically-arranged silicon nanopillars of varying sizes and interpillar gaps were fabricated to enable the exploration of the SERS response from two different structures; one featuring only localized surface plasmon (LSP) modes and the other featuring LSP and propagating (PSP) modes. It is shown that the LSP modes determine the optimal architecture, and thereby determine the optimum diameter for the structures at a given incident. However, the increase in the SERS enhancement factor for a system in which LSP and PSP cooperatively interact was measured to be over an order of magnitude higher and the peak in the diameter dependence was significantly broadened, thus, such structures not only provide larger enhancement factors but are also more forgiving of lithographic variations.

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