Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Linear Optical and SERS Study on Metallic Membranes with Subwavelength Complementary Patterns QINGZHEN HAO, YONG ZENG, LASSE JENSEN, DOUGLAS WERNER, VINCENT CRESPI, TONY JUN HUANG, Pennsylvania State University, INTERDEPARTMENTAL COLLABORATION — An efficient technique is developed to fabricate optically thin metallic films with subwavelength patterns and their complements simultaneously. By comparing the spectra of the complementary films, we show that Babinet's principle nearly holds in the optical domain. A discrete-dipole approximation can qualitatively describe their spectral dependence on the geometry of the constituent particles and the illuminating polarization. Using pyridine as probe molecules, we studied surface-enhanced Raman spectroscopy (SERS) from the complementary structure. Although the complementary structure posses closely related linear spectra, they have quite different near-field behaviors. For hole arrays, their averaged local field gains as well as the SERS enhancements are strongly correlated to their transmission spectra. We therefore can use $\cos^4\theta$ to approximately describe the dependence of the Raman intensity on the excitation polarization angle θ, while the complementary particle arrays present maximal local field gains at wavelengths generally much bigger than their localized surface plasmonic resonant wavelengths.

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Date submitted: 15 Nov 2010 Electronic form version 1.4