Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Dielectric function trajectory of ultrathin gold films XUEFENG WANG, DAVID NOLTE, Purdue University — There have been attempts to study the complex refractive index $\tilde{n}_g$ of gold films by ellipsometry, but the measurements become unreliable when the average film thickness is below several nanometers, presumably because of optical anisotropy of the thin film. Here, we apply interferometric picometrology to measure $\tilde{n}_g$ by analyzing the Fourier-domain anisotropic diffraction of a normal-incidence scanning Gaussian laser beam reflected by a stripe-patterned gold film. The $\tilde{n}_g$ and dielectric constant ε_g of the gold film were measured for thicknesses ranging continuously from 0.1 nm to 10 nm at a wavelength of 488 nm. Three distinct regimes of the ε_g trajectory on the complex plane were observed as the gold thickness increased. The first regime (gold thickness: 0.1 nm $\sim$ 0.7 nm) reveals an evolution from sparse clusters to dense clusters. The real part of ε_g changes from 2.3 to 7.0 and the imaginary part changes from 0 to 0.7. The Maxwell-Garnett equation is applied for this regime by treating the film as an effective medium consisting of air and gold clusters. The second regime (0.7 nm$\sim$ 2 nm) is a linear curve of ε_g suggesting a transition from isolated clusters into a continuous thin film. The third regime (2 nm $\sim$ 10 nm) shows a circular trajectory of ε_g moving towards the bulk value, which can be interpreted by the Drude equation.

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Date submitted: 03 Dec 2008 Electronic form version 1.4