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Drude Circle for Ultra-Thin Gold Films Observed by Picometrology DAVID NOLTE, XUEFENG WANG, Purdue University — In picometrology, a Gaussian laser beam at normal incidence on the edge of a thin film deposited on a substrate reflects to form a diffraction pattern on a Fourier plane. The complex index of the film is acquired by analyzing the symmetric and anti-symmetric components of the far field diffracted intensity. We have measured the effective index and dielectric constant of gold film as the thickness varies continuously from 0.1 nm to 10 nm at wavelengths of 488 and 532 nm. Three distinct regimes of the dielectric function trajectory on the complex plane are observed as the gold thickness increases. The regimes are interpreted in terms of gold cluster topology acquired from high-resolution SEM imaging. The substrate coverage and the size and aspect ratio of clusters determines the effective dielectric constant of a gold film. Of particular interest is the evolution of the dielectric constant along a circular trajectory in the thickness range of 2 to10 nm. This trajectory is the so-called "Drude circle" that occurs as the gold cluster size becomes smaller than the electron mean free path. We have unambiguously observed the Drude circle in the picometrology experiments. We gratefully acknowledge helpful discussions with V. Shalaev and help with SEM data from Kuo-Ping Chen.

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