Morphology and Optical Properties of Gold Island Films Formed by Annealing of Percolated Evaporated Gold Layers

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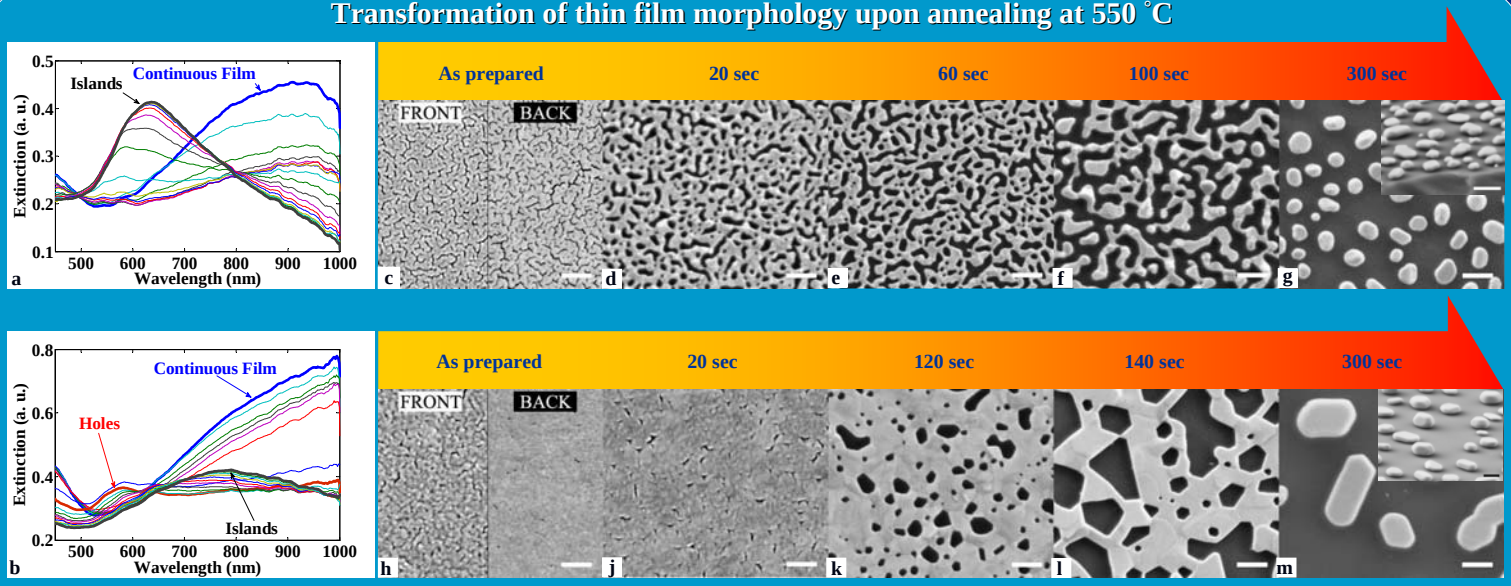
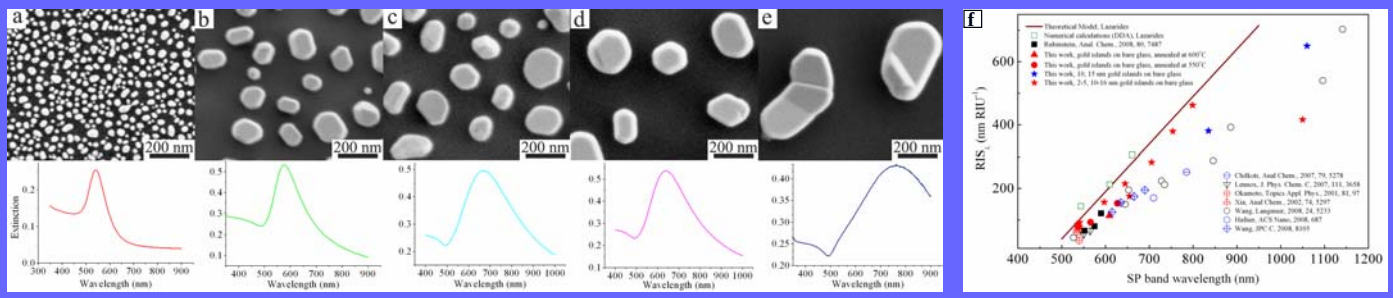
Au island films supporting localized surface plasmon resonance (LSPR) are of interest as optical transducers in a variety of sensing applications based on local refractive index change. Development of a simple and scalable technology allowing tuning of the surface plasmon (SP) band is challenging due to the relatively high cost of lithography-based patterning and the unsatisfactory reproducibility of colloid-based schemes. The sensitivity of LSPR transducers scales with island size, making the preparation of films with large islands highly attractive for the development of actual sensors. Increase of the average island size can be achieved relatively easily by thermal annealing of as-evaporated Au films. Here we explore a different route to the preparation of Au films with large islands on glass substrates, using continuous evaporated Au layers which undergo depercolation upon annealing. The refractive index sensitivity (RIS, as wavelength shift) of Au island films prepared by thermal depercolation shows exceptionally high values, up to 700 nm/refractive index unit, almost an order-of-magnitude higher than previously reported values for Au island films. This opens intriguing possibilities for new applications requiring particularly high sensitivity, such as LSPR imaging.

Transformation of thin film morphology upon annealing at 550 ˚C



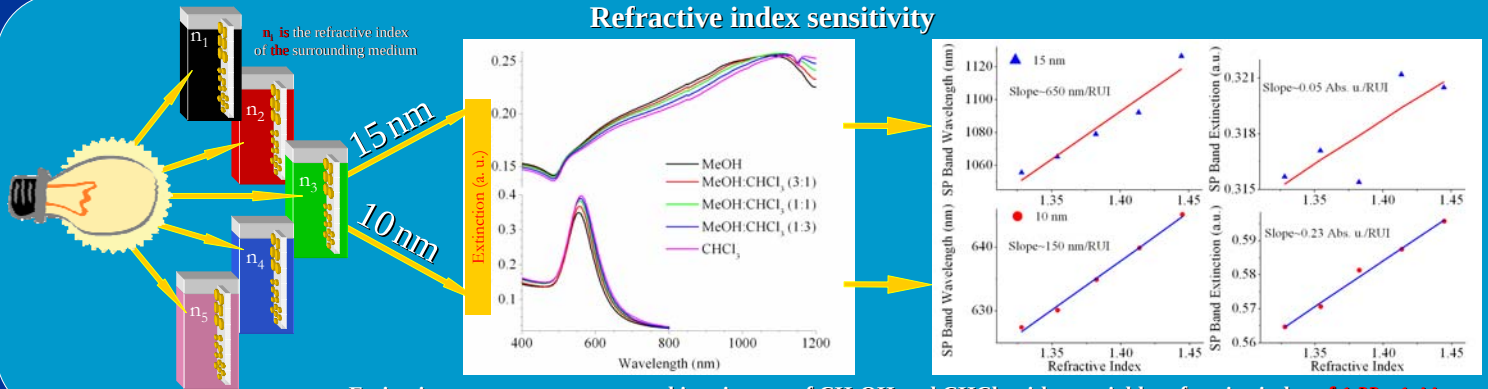
Annealing at 550 ˚C of 10 nm (top) and 15 nm (bottom) Au films evaporated on glass. (a, b) In situ transmission spectra. (c-m) High-resolution SEM (HRSEM) images. The back side in (c) and (h) was imaged after dissolution of the glass substrate in HF. Insets in (g) and (m): isometric projections at a tilt angle of 20˚. Scale bar: 200 nm.

Tuning of the islands optical properties and comparison with RIS of other systems



HRSEM images and extinction spectra of Au films annealed 10 hours at 550 ˚C. Nominal thickness (nm): (a) - 5, (b) - 10, (c) - 12, (d) - 13, (e) - 15. (f) – theoretical calculation of the refractive index sensitivity (continuous line) and experimental results for different systems.

Refractive index sensitivity



Extinction spectra were measured in mixtures of CH_3OH and $CHCl_3$ with a variable refractive index of 1.33 - 1.44.