Near-field study of localized and extended surface plasmon resonance on gold nanoislands

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We present a study of localized and extended surface plasmons on size-tunable gold nano-islands by scanning near-field optical microscopy (SNOM). The gold nanoislands are self-assembled by a thermal annealing process of an Au thin film. The morphology and density of the nanoislands can be controlled by modifying the initial thickness of the Au thin film and the thermal treatment conditions [1].

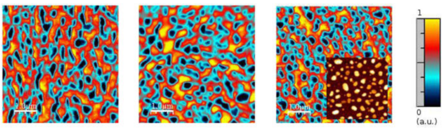

Figure 1: 5umx5um SNOM images of three different samples of gold nanoislands annealed at 300°C, 400°C and 500°C (left to right). Inset: 2.5umx2.5umAFM topography of the corresponding sample.

A surface plasmon (SP) resonance is a collective oscillation of the conduction electrons in a metallic-dielectric interface. It leads to a huge absorption cross-section at a specific frequency. SPs behave as travelling charge waves in the interface between a dielectric and a noble metal film (extended SPs), or can be spatially confined in the boundaries of nanoparticles (localized SPs). Localized SPs in nanoparticles can be easily excited by incoming light, leading to an easily recognizable peak in a routine absorbance spectrum. On the other hand, extended SPs require special matching techniques in order to be coupled to light. While this can be done in different ways, the only method capable of giving local information on the nanoscale is near-field coupling, in which a SNOM tip is used as a surface plasmon point source [2].

In this work we present a systematic study of gold nanoislands fabricated under different annealing temperatures or initial Au thin film thickness. We use SNOM to show how the surface plasmon behavior depends on the islands size and inter-particle distance. We will also show preliminary results on SNOM spectroscopy. Our aim is to understand the SP resonance frequency shifts and find the frontier between localized and extended surface plasmons.

References

[1] A. Serrano, O. Rodríguez de la Fuente, and M. A. García, Journal of Applied Physics 108, 074303 (2010).

[2] S. A. Maier, Plasmonics, Fundamentals and Applications (Springer Science+Bussines Media LLC, New York, 2007), pp. 39-50.