Highlights

Plasmonics of Au nanoparticles in a hot thermodynamic bath

Michele Magnozzi,[1] Marzia Ferrera[1], Lorenzo Mattera[1], Maurizio Canepa,[1] and Francesco Bisio[2]

[1]OptMatLab, Dipartimento di Fisica, Università di Genova, via Dodecaneso 33, I-16146 Genova, Italy
[2]CNR-SPIN, C.so Perrone 24, I-16152 Genova, Italy

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Electromagnetically-heated metal nanoparticles can be exploited as efficient heat sources at the nanoscale. The assessment of their temperature is however often performed indirectly by modelling their temperature-dependent dielectric response. Direct measurements of the optical properties of metallic nanoparticles in equilibrium with a thermodynamic bath provide a calibration of their thermo-optical response, to be exploited for refining current thermoplasmonic models or whenever direct temperature assessments are practically unfeasible.

We investigated the plasmonic response of supported Au nanoparticles in a thermodynamic bath from room temperature to 350 °C by means of spectroscopic ellipsometry (SE). SE measures the variation of the state of polarization of light upon interaction with the sample, quantified by the spectral functions ψ and Δ. A model explicitly including the temperature-dependent dielectric function of the metal and finite-size corrections to the nanoparticles permittivity correctly reproduced experimental data for temperatures up to 75 °C. The model accuracy gradually faded for higher temperatures. Introducing a temperature-dependent correction that effectively mimics a surface-scattering-like source of damping in the permittivity of the nanoparticles restored a good agreement with the data. A finite-size thermodynamic effect such as surface pre-melting may be invoked to explain this effect.

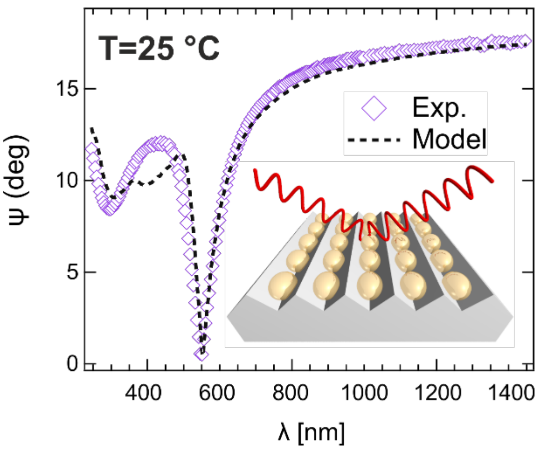

Fig. 1: Open symbols: ellipsometric spectrum ψ(λ), of arrays of Au nanoparticles at room temperature. Dashed line: theoretical model based on an effective-medium theory. ψ is defined as the ratio of the moduli of the complex Fresnel reflection coefficients r_p and r_s.

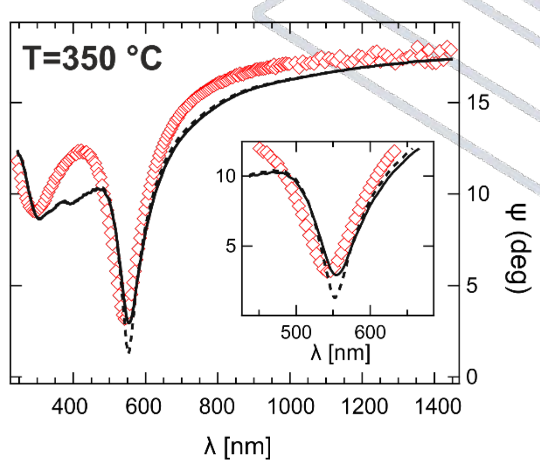

Fig. 2: Open symbols: ellipsometric spectrum ψ(λ) of arrays of Au nanoparticles at 350°C. Dashed line: theoretical model without surface premelting. Continuous line: model calculations with surface premelting included.