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CONTRIBUTION OF CHEMICAL INTERFACE DAMPING TO THE SHIFT OF SURFACE PLASMON RESONANCE ENERGY OF GOLD NANOPARTICLES

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Abstract. The effects that determine the shift and damping of the surface plasmon resonance (SPR) band of colloidal gold nanoparticles due to the chemisorption of tetrahydroxyborate ($B(OH)_4$) anions are analyzed experimentally and theoretically. The contribution of chemical interface damping, change in refractive index and charge density variations to the experimentally observed shift of the SPR band are evaluated qualitatively by simulating the optical response of gold nanoparticles upon the chemisorption of $B(OH)_4$ anions. The results show that changing the refractive index of the medium and the charge density cannot account entirely for the shift of the SPR band. Thus, chemical interface damping should be considered when analyzing surface effects in the presence of strongly chemisorbed adsorbates.

Key words: gold nanoparticles; chemical interface damping; Drude model; surface plasmon resonance.

1. INTRODUCTION

Optical properties of plasmonic structures are of great interest in many nanotechnological applications, but also for understanding surface effects in plasmon–driven catalysis or surface-enhanced Raman scattering. Among the metallic nanoparticles, gold nanoparticles (AuNPs) are the most widely used due to the ease of surface chemical functionalization and increased bioavailability compared to other metallic nanoparticles. Additionally, numerous studies reported the possibility of using the surface of metallic gold or silver nanoparticles (AgNPs) for specific chemical reactions, which represents the holy grail of catalysis – to promote selectively the chemical transformation of a target molecule from a mixture containing multiple analytes [1–3]. Such selective chemical reactions can be achieved due to an additional energy provided by resonantly excited plasmons, energy that can be transferred selectively to chemically adsorbed molecules.

From a rigorous point of view, a plasmon is defined as a quantum quasi-particle representing the elementary excitation, or mode, of the charge density oscillation in