Rhodium Nanocubes for plasmonics in the UV range

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Abstract

Extending nanoplasmonics to the UV-range constitutes a new challenge due to the increasing demand to recognize, detect and destroy biological toxins[1], to increase the efficiency of photocatalytic processes[2] or enhance biological imaging[3]. A study by J. M. Sanz et al.[4] analyzed several metals in order to find those more promising for UV-plasmonics. This work pointed out that those most promising were aluminum (Al), gallium (Ga) and rhodium (Rh). Aluminum has a bulk plasma frequency around 13 eV and a strong plasmonic response. However, nanoparticles made of this material suffer from oxidation[5], so it is difficult to manufacture effective and stable Al nanodevices. As a promising alternative, Ga nanoparticles have been recently proposed for Surface Enhancement Raman Scattering (SERS) experiments[6]. However, this metal presents a solid-liquid phase transition at room temperature that hinders its manipulation for other kind of applications. More recently, a numerical study has presented Rh[7] as one of the most promising metals, not only for its plasmonics behavior in the near UV, but also because it presents a low tendency to oxidation. Moreover, its easy fabrication through chemical means[7–9] (with sizes smaller than 10 nm), and its potential for photo-catalysis applications, makes this material very attractive for building plasmonic tools for the UV.

In this contribution, we will show an overview of our collaborative research with rhodium nanocubes (NC) in the UV-range[9]. The electromagnetic behavior of Rh nanocubes of different sizes (ranging from 10 to 60 nm) has been numerically analyzed and compared with experimental measurements made by UV-VIS extinction spectroscopy. Because the chemical process does not produce perfect cubic shapes, other Rh cubic-based geometries have also been numerically studied, and their effect on the LSPRs spectra of these deviations have been analyzed. In addition, for many applications it is interesting to use arrays of nanoparticles located on substrates because of the appearance of cooperative and coupling effects between particles. LSPRs spectra for these types of geometries have been also studied for different experimental configurations.

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