Using linear polarization for sensing with core-shell nanostructures

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The interaction of light with metallic nanoparticles (NPs) has been a very active field that has impacted many different areas. For instance, the development of new sensing techniques especially has attracted the attention of researchers in science and engineering [1]. However, in spite of the strong response of metallic NPs in infrared and visible spectral regions, their metallic nature is also the cause of their main disadvantage, ohmic losses. High Refractive Index (HRI) dielectric NPs have been proposed as a means to address this issue. Some of their most important advantages are they do not show loses and also they can show new scattering effects due to magnetic contributions even for non-magnetic ($\mu = 1$) materials, [2]. This magneto-dielectric behavior is responsible for interesting directionality properties. Under certain conditions, proposed by Kerker et al [3], the forward and backward scattered intensity is almost null or null respectively. The spectral response depends on the NP size, its refractive index, its purity and the refractive index of the surrounding medium m_{med}. Due to this last dependence, dielectric NPs can be used for sensing proposes. In recent publications, the sensitivity of different semiconductor materials to changes in m_{med} has been studied attending to energy or polarimetric measurements, [4-5]. In this work, we propose to analyze the sensitivity to m_{med} of metallo-dielectric core-shell NPs through the measurement of the spectral linear polarization degree at right angle scattering, $P_L(90º)$. The results of this study have been compared with those for a HRI dielectric NP in the same spectral range.

For particles much smaller than the incident wavelength, both directionality conditions are satisfied when $P_L(90º) = 0$. In this work, using the Lorenz-Mie theory and focusing on the spectral shift of the $P_L(90º)$ at both Kerker's conditions as a function of m_{med}, we show the utility of $P_L(90º)$ spectral measurements for sensing applications. As an example, in Fig. 1 we show the sensitivity, ξ_m, of $P_L(90º)$ to m_{med} for the first (Zero-Backward) and second (near Zero-Forward) Kerker conditions for a core-shell Si-Ag spherical NP as a function of the core size [6]. The external (core+shell) radius was fixed to R_{ext} = 230nm.

References

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Figures

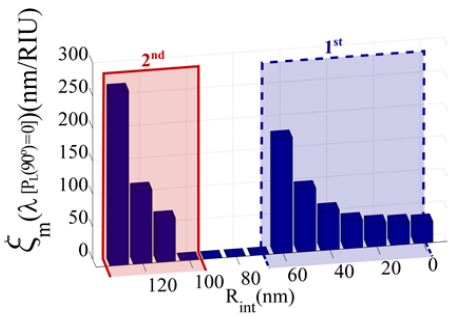

Figure 1: Sensitivity of $P_L(90º)$ to the refractive index of the surrounding medium, m_{med}.