Towards the Polarization Control of the Directional Scattering of Semiconductor Nanodisks

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Abstract- In this work we analyze the sensitivity of the directional scattering conditions in semiconductor nanodisks with the polarization of the incident light. The possibility to reach or not this directional scattering as a function of the polarization of the incident beam could be very interesting for the design of new all-optical devices for optical communications and computing.

In the last years, light scattering of semiconductor nanoparticles becomes an attractive field due to the appearance of both electric and magnetic resonances, as well as the satisfaction of the Kerker's conditions [1, 2]. These effects are currently the base of a new research line devoted to the analysis and design of new dieletric devices, like all-optical switches [3]. Kerker's conditions were established in the last century, but they are intensely studied in the last few years [4, 5]. They were proposed considering spherical dipole-like particles. However, these effects can also be observed in other geometrical structures, like disks [6]. In addition, while the zero-forward condition is strongly sensitive to any change, the zero-backward condition is more stable.

In this work, we have considered nanodisks made of different high-refractive index semiconductor materials on a substrate and illuminated with a linear-polarized small-incident-angle beam (see Fig. 1). By means of FEM simulations (®Comsol), we observed the directional conditions at an incident wavelength of 632.8 nm (He-Ne laser) and considering a TE polarization. As the incident polarization changes (TM mode) the directional conditions are not satisfied anymore and the spatial distribution of the electric field in the surroundings of the nanodisk strongly changes. Both the radius and the height of the disk were optimized to obtain a maximum contrast between both polarizations.

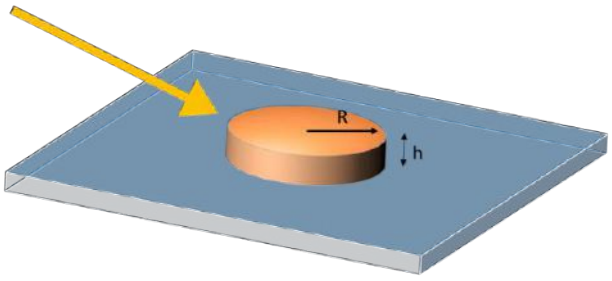

Figure 1. Scheme of the considered geometry. Light impinges at 10º with respect to the substrate plane.

This polarization sensitivity is now applied to design a polarization-driven switch based on two nanodisks, producing a strong concentration of light if the directional conditions are satisfied, and a poor light intensity in any other case.

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