

Analysis of localized plasmonic resonances in nano-disk arrays

M. Lorente-Crespo⁽¹⁾, G. C. Ballesteros⁽²⁾, C. Mateo-Segura *⁽¹⁾, and C. Garcia-Meca⁽³⁾

(1) Institute of Sensors, Signals and Systems, Heriot-Watt University, EH14 4AS, Edinburgh, United Kingdom

(2) Institute of Photonics and Quantum Sciences, SUPA, Heriot-Watt University, EH14 4AS, Edinburgh, United Kingdom

(3) Nanophotonics Technology Center, Universidad Politecnica de Valencia, Camino de Vera s/n, 46022, Valencia, Spain

Metallic nano-particles support localized surface plasmon resonances (LSPRs) associated with the interaction of free electrons on the metal surface and incoming light. LSPRs can enhance the electric field by several orders of magnitude while confining it to sub-wavelength regions. Recently, we showed that arrays of closely spaced nano-rings can also enhance and localize the magnetic field. Our results showed that the inner radius had very little effect on their performance. Therefore, simpler nano-particles may be used, i.e. nano-disks. Recently, nano-disk arrays have been proposed as building blocks for broadband absorbers. These structures rely on the presence of multiple resonances when nano-disks of different dimensions are combined or, at normal incidence, when odd order multipolar LSPRs are excited.

In this contribution, the angular absorption response of a square array of silver nano-disks operating in the visible range is thoroughly studied, Fig. 1. Our simulations show that unlike for normal incidence even order multipolar rim LSPRs can be lighted up under TE oblique illumination. Such resonances manifest as absorption peaks in the scattering spectra. The extinction-cross section of a single isolated nano-disk confirmed their localized nature. When arranged in arrays, the resonance frequencies show very little dependence on the periodicity and angle of incidence. On the contrary, they are highly affected by the radius of the nano-disks. The dispersion curve of the LSPRs was obtained from full-wave simulations performed using CST Microwave Studio 2013. As expected for rim modes, an integer number of wavelengths must exactly fit the perimeter. The effect of altering the thickness of the nano-disks was also investigated. Two distinctive regimes were identified and studied: a) for very thin nano-disks where the modes of the two rims are degenerate; b) for medium-thick disks where the modes interact with each other so that two hybridized modes with opposite phase distribution appear. The discussion of these results will be the focus of our presentation.

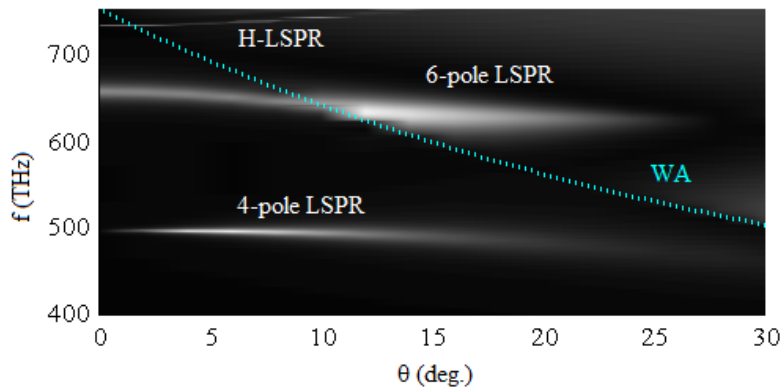


Figure 1 Angular absorption spectra of the nano-disk array. Woods Anomaly is shown in cyan.