NANOSPEAR PLASMONS

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Design and engineering effective near-field scanning optical microscopy tips is a challenging topic of research to improve field-enhanced microscopy and spectroscopy. Current approaches focus on different resonant antenna effects to obtain maximum scattering signal and enhanced molecular fluorescence. Other research efforts are devoted to take advantage of certain structural resonances, such as those in cavity modes [1], or in sets of varying-size nanoparticles [2] where hot spots of field enhancement are created.

In this contribution, we propose a nanospear structure at the end of a scattering metallic tip as an effective geometry that generates largely increased field enhancement at the arms of the spear. The mechanism of the additional enhancement of the nanospear, compared to a standard conical or ellipsoidal tip, is based on the presence of the additional cavities that act as reservoirs of induced charge oscillation, allowing a larger enhancement to occur in the proximity of the tip arms, in what we describe as the nanospear plasmon.

With use of a boundary element method (BEM), we perform full electromagnetic calculations of the optical scattering by a metallic nanospear-shaped tip, and map the plasmon patterns induced in this geometry (Fig. 1). The field enhancement around the nanospear tip is 10 times larger than in a standard rounded tip of the same radius. These results corroborate the influence of the combined presence of concave and convex surfaces as the sources of the enhancement. We study plasmon patterns and surface charge density in different nanospears to obtain maximum efficiency. The maximum enhancement occurs at the edges of the nanospear arms with values around 500, that make this structure a robust candidate to be used in tip-enhanced spectroscopies.

References:

[1] I.Romero, J.Aizpurua, G.W.Bryant, F.J.García de Abajo, Optics Express **14**, 9988 (2006).

[2] L. Kuiru, M.I. Stockman, and D.J. Bergman, Phys. Rev. Lett. **91**, 227402 (2003).

Figures:

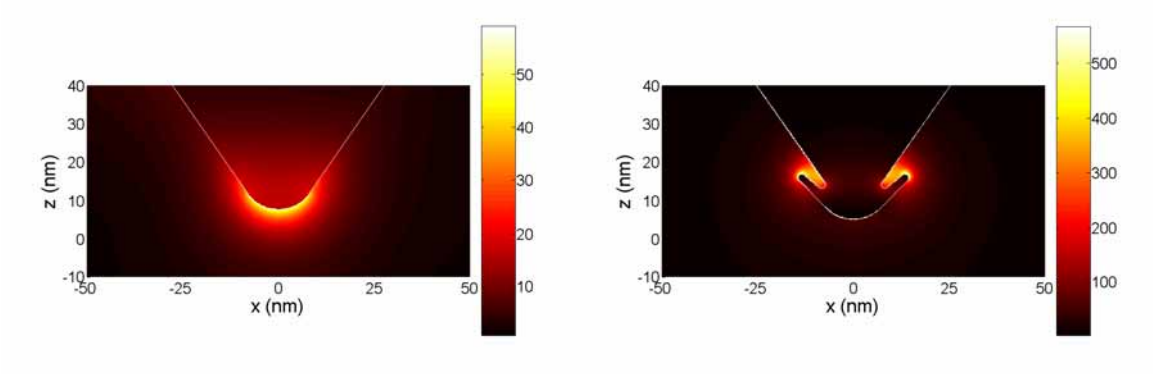

Fig. 1: (Left) Near-field distribution around a silver rounded tip with a radius of curvature R=10nm for a polarized planewave coming from the left hand side. (Right) Near-field distribution around a nanospear shaped tip, with the same overall radius of curvature. An amplitude field enhancement larger than 500 is observed around the arms of the nanospear