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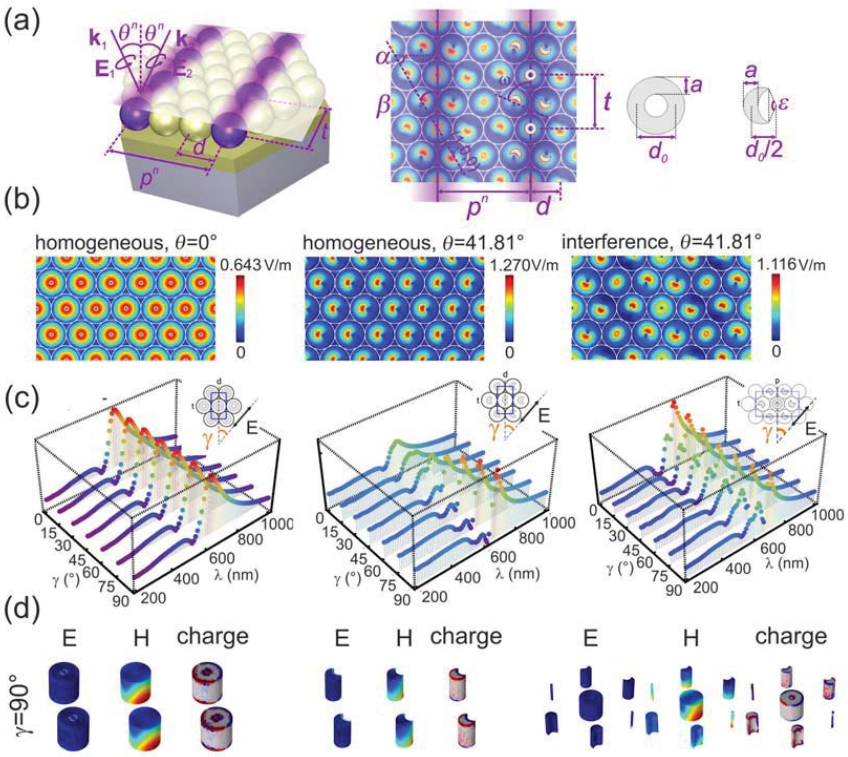
Tunable Plasmonic Properties of Rounded Object-Arrays Achievable Via Interferometric Illumination of Colloid Sphere Monolayers

Áron Sipos, **Anikó Somogyi**, Gábor Szabó, Mária Csete

Department of Optics and Quantum Electronics, University of Szeged, Szeged, Hungary

Interferometric illumination of colloid sphere monolayers (IICSM) by circularly polarized beams makes possible to fabricate complex patterns consisting of wavelength-scaled arrays of rounded nano-objects. By applying the IICSM method to illuminate metal colloid sphere monolayers rectangular patterns of mini-arrays consisting of various rounded nano-objects can be generated. The IICSM method requires the perfect synchronization of a desired intensity modulation with respect to preselected colloid sphere arrays inside hexagonally close packed monolayers [1]. It was demonstrated that via IICSM method complex patterns with six independently tunable geometrical parameters can be fabricated. The spectral and near-field effects of three complex patterns, which can be generated via illumination (i) by perpendicularly and (ii) oblique incident homogeneous beam and (iii) in IICSM-configuration were studied by finite element method. The azimuthal orientation dependent spectra of hexagonal arrays of (i) nano-rings and (ii) nano-crescents, as well as of (iii) rectangular pattern of mini-arrays is presented. It is demonstrated that the (iii) rectangular pattern of mini-arrays consisting of a central nano-ring and satellite nano-crescents have unique capabilities in spectral tunability, and in tight near-field confinement. The near-field and charge distribution on these structures were inspected at several azimuthal orientations, and were compared to calculations made previously on hole-doublets achievable via illumination by linearly polarized light [2, 3].



(a) Presentation of the IICSM method and of the six independently tunable geometric parameters; (b) hexagonal arrays of (i) nano-rings and (ii) nano-crescents, and (iii) rectangular pattern of mini-arrays. (c) Azimuthal angle (*γ*) and wavelength (*λ*) dependent transmittance spectra with each unit cell used for calculation, (d) 3D near-field and charge distribution on rounded objects achievable via homogeneous illumination and IICSM at transmittance maxima arising at γ=90° azimuthal orientation of rectangular patterns of mini-arrays in a gold film.

[1] Á. Sipos, A. Szalai, M. Csete, Proc. SPIE 8323, 83232E (2012)

[2] M. Csete, Á. Sipos, A. Szalai, G. Szabó, IEEE Photonics Journal 4, 1909 (2012)

[3] Á. Sipos, A. Somogyi, G. Szabó, M. Csete, Plasmonics 9, 1207 (2014)