allied academies

International Conference on

# Nanomaterials and Nanochemistry

November 29-30, 2017 | Atlanta, USA

## Comparative study on patterns of rounded concave and convex objects achievable via integrated lithography realized by circularly polarized light

**Mária Csete**
University of Szeged, Hungary

Comparative study has been performed on the spectral and near-field properties of concave and convex nano-object-patterns that can be fabricated via colloid-sphere lithography (CSL) and via interferometric illumination of colloid sphere monolayers (IICSM) by applying circularly polarized light. Previous studies on hole- and disk-arrays in the literature have shown that the s/p-polarized transmittance on the former corresponds to the p/s-polarized reflectance on the latter type of patterns, according to the Babinet principle. In CSL hexagonal pattern of nano-ring and nano-crescent shaped holes can be prepared via illuminating a hexagonal monolayer of Au colloid spheres by perpendicularly and obliquely incident circularly polarized beams, as a result two and four geometrical parameters can be tuned independently. In IICSM mini-arrays composed of a central ring and satellite nano-crescents can be fabricated via illuminating a hexagonal monolayer of Au colloid spheres by two interfering circularly polarized beams, and six geometrical parameters (p pattern period, t nano-object distance, d nano-ring and nano-crescent diameter, $\varepsilon$ nano-crescent opening angle and $\omega$ orientation) can be tuned independently (Fig. 1a, b). When the Au colloid sphere monolayers are aligned on thin Au films, nanoholes of various shape can be directly fabricated, while a lift-off procedure makes it possible to transfer the pattern into analogous convex nano-objects. Both of the concave and convex hexagonal patterns of nano-rings and nano-crescents, as well as of the two different (p=300 nm and p'=600 nm) rectangular patterns of mini-arrays were re-illuminated by p-polarized light in different azimuthal orientations to demonstrate their spectral engineering capabilities. Our results have shown that in complementary complex patterns illuminated by complementary beams the reflectance and transmittance are interchanged. The convex patterns indicate the cavity resonances of individual nano-objects and the lattice resonances on their array, while the optical response of the concave patterns is more structured due to the Fano modulations originating from coupled localized and propagating modes. The spectra on the hexagonal pattern of nanorings did not show azimuthal orientation dependence, while the spectra on the hexagonal pattern of nano-crescents and on both rectangular patterns composed of analogous miniarrays strongly depend on the azimuthal orientation. The hexagonal pattern of nano-rings indicates the "U-resonance" of crescent-shaped objects, which is independent of the E-field oscillation direction due to their symmetry properties. In contrast, on the hexagonal pattern of nano-crescents the convex reflectance in $\gamma$=0°/90° corresponds to the concave transmittance in $\gamma$=90°/0° azimuthal orientation (Fig. 1c). Similarly, on the rectangular pattern of mini-arrays the convex reflectance in 30°/120° azimuthal orientation corresponds to the concave transmittance in $\gamma$=120°/30° (Fig. 1e). On both rectangular patterns of miniarrays at small wavelength analogous extrema are observable, while the larger periodic rectangular pattern exhibits additional extrema at larger wavelengths. The charge distribution and corresponding near-field indicates U / C1 and C2 resonance on the convex hexagonal array of nano-crescents in $\gamma$=90°/0° azimuthal orientation, while on the convex rectangular pattern analogous resonances appear in $\gamma$=30°/120° (Fig. 1d, f). However, the charge and near-field distribution on the complementary concave pattern is perturbed by coupled localized and propagating modes.

**e:** mcsete@physx.u-szeged.com