An integrated lithography method is presented to prepare rounded nano-objects with variable shape, in arrays with arbitrary symmetry and wavelength-scaled periodicity. Finite element method was applied to determine the near-field confinement under silver and gold colloidal spheres, monolayers illuminated by circularly polarized beams possessing periodic intensity distribution, and to predict the shape of nano-objects, which can be fabricated on the delicate metal layers on glass substrates. It was shown that illumination by perpendicularly incident homogeneous beam results in hexagonal array of uniform nano-rings, while uniform-size nanocrescents appear due to single elliptically incident beam. The local intensity distribution is fundamentally influenced by the wavelength and angle of incidence, the inter-object distance is controlled by the relative orientation of interference patterns with respect to colloids spheres monolayers, the nano-object size is determined by the wavelength, size, and periodicity, while the near-field confinement sensitivity depends on the direction of illumination by circularly polarized light. We present composite patterns of various rounded objects that can be uniquely fabricated via Circular Interference and Colloidal sphere Lithography (CIICL), and applied as plasmonic and meta-materials.

2. THEORETICAL METHODS

Illustration of co-planar illumination of two interfering circularly polarized beams (a) CIICL-I geometry, where the angle of incidence (θ) and the tilt of the incidence plane (α) is indicated, and (b) CIICL-II geometry. (c) The relative orientation of the plane of incidence (α), and the interference pattern (θ), with respect to the (1, 0, 0) crystallographic direction in CIICL-I (blue) and in CIICL-II (red) geometries. The interaction of two beams is oriented at the angles indicated (α, θ).

The size parameters of the two objects are diameter (d), thickness (t), and gap-angle (ε).

REFERENCES

4. CONCLUSION

We introduce a circularly polarized interference lithography and colloid sphere lithography. This integrated lithography combines the advantages of these two techniques, as the symmetry and periodicity of the wavelength-scaled interference modulation determines a particular pattern, while the intensity confinement in the near-field domain of the circularly polarized beams holds. The local intensity distribution is fundamentally influenced by the wavelength and by the colloid spheres material and diameter together. The local intensity distribution is fundamental to the specific, spectral, and spatial excitation. illumination close to Fano-resonant condition results in extremely light field confinement. The orientation of the non-rotationally symmetric objects with respect to the (1, 0, 0) direction and to the interference pattern is determined by the illumination direction of hexagonal co-planar colloid sphere monolayers. This orientation might be tuned by varying the incident angle, incidence plane, wavelength, and size of the spherical material in specific spectral interval. The local intensity distribution is fundamental to the spatial orientation of objects with respect to the specific, spectral, and spatial excitation. The size and the orientation of these objects can be varied using arrays with this technique, which is important in meta-material design.