Surface plasmon polaritons in 2D metal nanoparticle structures

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Recent experimental advances in fabrication of ordered and partially ordered planar structures of metal nanoparticles open an avenue for various attractive applications of such “artificial solids”. Their optical properties, determined by the surface plasmon-polariton (SPP) excitations, are quite different from the optical properties of individual nanoparticles and their colloids, since the effects of electrodynamic coupling between the particles become of a great importance.

We study optical properties of a planar monolayer made of noble metal nanoparticles in the framework of the statistical theory of multiple scattering of waves. This approach allows us to analyze the effects of different types and degrees of nanoparticles ordering inside a monolayer over the wide range of particle sizes, concentrations and matrix refractive indices.

The revealed effects include: (i) change of the direction of the *size shift* of SPP’s spectral band, from blue to red with enlarging particles sizes, for highly dense monolayers; (ii) fundamental dependence of both the value and the direction of the *concentration shift* of SPP's spectral band on the size of arranged particles; and (iii) structural modification of the SPP’s spectral band with the change of the degree of particles ordering for particles with sufficiently large diameters. We analyse the obtained results on the basis of the effects of coherent overirradiation for partially correlated particles and additional excitation of higher-order multipoles, under the condition of essentially evanescent effective field reached in close-packed monolayers.