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EXTREME EFFECTS IN MAGNETIC FIELD LOCALIZATION AT DIELECTRIC MESOSCALE PARTICLES

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In optics, the weakly dissipating dielectric spheres permit to realize high-order Fano resonances associated with internal Mie modes [1,2] and the field structure has no WGM structure. These resonances for specific values of the Mie size parameter of dielectric sphere yield field-intensity enhancement factors about 10^4–10^9, at a unique arrangement of hotspots at the poles of the sphere, which can be directly obtained from analytical calculations based on Mie theory. These “super-resonances” (SR) [3] provide magnetic hot spot with giant magnetic fields, which is attractive for many applications [4-6]. This provides a new physical phenomenon to obtain extreme field localization with giant field enhancement, which is comparable to that for plasmonics. The disadvantages of high magnetic fields generation by SR’s are strong sensitivity to the losses in the mesoscale particle material and Mie size parameter. Note that such a magnetic field is comparable with magnetic cumulative generators. For SR condition, the local ratio of wave vectors in singular points near the outer surface of a particle can reach K_0/K_l~10^2, where K_0 is a wave-vector of incident wave [2]. So the giant magnetic fields can be created inside the dielectric particle due to creating subwavelength optical vortices with large phase gradients in the vicinity of singularities [2]. The new effect of a decrease in the size of the field localization (hotspots) down to less than the diffraction limit was found when small losses are introduced into the sphere material, which can be even less than in the ideal case of the particle material without losses [5].

Moreover, while spherical mesoscale dielectric particle shapes have only 2 degrees of freedom (Mie size parameter q and refractive index of the particle material), sphere with broken symmetry [7], composed of 2 different dielectrics, provide additional degrees of flexibility in electromagnetic response tuning to generate strong magnetic hot spots.

Our investigations shown that in the structures under consideration it is necessary to take into account the change in the refractive index of the environment (air), the structure of the material of the particle (different local density) and the value of the "roughness" of its surface.

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