# **All-dielectric nanoparticles embedded in media: Broadening and amplification of forward scattering**

100-word abstract: Now it is 92 words

In this work we study scattering effect from all-dielectric nanoparticles embedded in media. We use semi-analytical multipole decomposition approach to calculate multipole contributions to the scattering cross-sections of the nanoparticles in media. We found that magnetic and electric multipoles, up to third orders, experience different red shift as refractive index of media increases. In addition, we noticed that high-order multipoles increase their influence on the scattering effect. We discuss the spectral broadening of forward scattering amplification effect based on the evolution of multipole moments when a particle is embedded in different media.

250-word abstract: Was 206, now it is 243

Light scattering by all-dielectric nanoparticles attract significant attention of photonics community. Single nanoparticles can be used both as nanoantennas and as building blocks to construct 2D and 3D meta-structures. In this work we study scattering effect when silicon nanoparticles are embedded in different media. To analyze the evolution of multipole moments and their contributions to the scattering cross-sections of the nanoparticles in media, we use semi-analytical multipole decomposition approach. Explicitly, we investigate the behavior of electric and magnetic multipoles, up to third order, while dielectric nanoparticle made of silicon is embedded in a media. We found that electric and magnetic multipoles experience different red shift as refractive index increases. Due to this behavior separated high-order multipole resonances overlap with each other; thereby, scattering cross section peaks, which in fact could be observed when a particles is in air, merge to the joint scattering cross section peaks. Such resonances overlap also affect both far-field radiation diagrams and field distribution inside the nanoparticle. Importantly, we noticed that when index of a surrounding media increases, the cubical nanoparticles provide spectral broadening of forward scattering effect.

Our results provide fundamental information for understanding the scattering effect in all-dielectric nanoantennas or metasurfaces embedded in different dielectric media and operating in wide spectral range. For practical applications, explored here dielectric nanoparticles could be utilized in broad range of applications such as in-vitro and in-vivo biomedical devices for sensing and drug efficiency monitoring, sub-marine nano-amplifiers, and many other emerging applications.