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Passive and Active Cylindrical and Spherical Coated Nano-Particle Systems at IR and Visible Wavelengths and Their Applications

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A variety of passive and active spherical coated nano-particle (CNP) systems have been studied as canonical source and scattering problems using analytical Mie-based solutions. Both plane wave and electric Hertzian dipole excitations of these CNPs have been investigated. A variety of dispersive passive and active materials have been included in these designs.

The more common plane wave source excitation problem solutions have been obtained and used, for instance, to design, highly subwavelength nano-particle lasers (J. A. Gordon and R. W. Ziolkowski, Opt. Exp., 15, 2622-2653, 2007). Both silver and gold coatings and canonical and three-level atom gain models were considered. The power density vector fields and the resulting vortices that are associated with the active CNP systems have been studied to explain the gain levels needed to achieve their very large scattering responses (S. D. Campbell and R. W. Ziolkowski, to appear in Opt. Commun., 2012). The complexity of the gain materials considered for the active CNPs has been explored with recent studies involving quantum dots for the gain mechanisms (S. D. Campbell and R. W. Ziolkowski, submitted to Opt. Lett., 2011).

The less common electric Hertzian dipole excitation problem solutions also have been obtained and used to design a variety of highly subwavelength nano-amplifiers and nano-sensors (S. Arslanagić and R. W. Ziolkowski, J. Opt. A, 12, 2010). These canonical problems have also guided advanced numerical studies of more complex open, as well as closed, geometries (J. Geng, R. W. Ziolkowski, R. Jin and X. Liang, IEEE Photonics, 3, 1093-1110, 2011). The impact of the metal choice has been determined (S. Arslanagic and R. W. Ziolkowski, Appl. Phys. A, 103, 795-798, 2011). The corresponding line source excited, passive and active cylindrical CNP problems have also been studied (S. Arslanagić, Y. Liu, R. Malureanu and R. W. Ziolkowski, Sensors, 11, 9109-9120, 2011). The possibility of tailoring the directive properties of these cylindrical and spherical nano-amplifiers has been explored recently (S. Arslanagić and R. W. Ziolkowski, Proc. META12, Paris France, 2012).

Our presentation will review these canonical problems, their solutions and their applications.