

Abstract

“OPTICAL AND PLASMONIC PROPERTIES OF COHERENT METAL-DIELECTRIC NANOCOMPOSITE MEDIA OF SILVER AND GOLD NANOPARTICLES EMBEDDED IN RUBIDIUM AS A HOST MEDIUM”

In this thesis, the optical and plasmonic properties of metal-dielectric nanocomposite media are theoretically studied via Maxwell-Garnett model by varying the size, shape, and volume ratio of the metal (silver and gold) nanoparticles in the coherently driven four levels rubidium dielectric atomic media. The optical response of this nanocomposite media strongly depends on the coherent driving fields applied in the atomic ensemble, volume fraction of the metal nanoparticles (NPs) along their size, and the applied frequencies. It was found that the dielectric function of the media decreases with increase in the NPs' size, while the dispersion and absorption coefficients increase with increase in volume fraction of the NPs. Similarly, the increase in Rabi frequency also increases the refractive index. Our results suggest important applications of this nanocomposite media in various fields such as energy harvesting, photovoltaics and quantum plasmonics. The modeling approach developed in this study provides great freedom for tuning optical properties of the metal-dielectric nanocomposites.

Rubidium being an alkali metal behaves as dielectric under quantum coherence effect, wherein this metal-dielectric nanocomposite was realized by considering uniformly embedded spherically shaped silver/gold nanoparticles in the coherently prepared rubidium atomic media. Our modelling approach takes into account the effects of the size, shape and volume fraction of NPs, and control field frequencies using localized surface plasmon resonance and atomic transitions in rubidium. Using a four-level atomic cascade configuration, this nanocomposite can be modelled to accurately manipulate its nonlinear optical response. The effective dielectric function of this nanocomposite is modelled to show

significant tunability in the real and imaginary parts of the dielectric function through external control fields. The plasmonic response induced by the metal nanoparticles give rise to enhancement of the optical properties of metal-dielectric nanocomposite media enabling it for applications in quantum photonics, plasmonic sensing, and tuneable nanophotonic devices. Moreover, the outcomes of this study demonstrate useful integration of plasmonic nanostructures with atomic systems for advanced photonic technologies.