Influence of active nano particle size and material composition on multiple quantum emitter enhancements: Their Enhancement and Jamming Effects

In the 150 years that scientists and engineers have used Maxwell's equations to describe electromagnetic phenomena, canonical scattering and radiating problems have played a very important role, providing explanations of and insights into their underlying physics. With the same intent, a variety of active coated nano-particles are examined here theoretically with regard to their ability to effectively enhance or jam the responses of quantum emitters, e.g., fluorescing molecules, and nano-antennas to an observer located in their far-field regions. The investigated spherical particles consist of a gain-impregnated silica nano-core covered with a nano-shell of a specific plasmonic material. Attention is devoted to the influence of the over-all size of these particles and their material composition on the obtained levels of active enhancement or jamming. Silver, gold and copper are employed as their nano-shells. The over-all diameters of the investigated coated nano-particles are taken to be 20 nm, 40 nm, and 60 nm, while maintaining the same ratio of the core radius and shell thickness. It is shown that the jamming levels, particularly when several emitters are present, are significantly larger for particles of larger sizes. These configurations are also shown to lead to the largest enhancement levels of the surrounding quantum emitters. Furthermore, for a fixed particle size and for a gain constant that produces the largest enhancement peak at optical wavelengths, it is demonstrated that these larger levels are most notable when the nano-shell is gold.

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