Graphene based nanocomposites

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There has been growing interest in the study of nanomaterials and their applications to nanotechnology. Several Nobel prizes have been awarded in the nano science research field including the recent Nobel prize (2010) for the study of graphene. Graphene is a two dimensional material made time it was studies by P. R. Wallace from Canada with whom I worked many years and published many papers from carbon atoms and first. Recently there is considerable interest for developing nanoscale optoelectronic devices by combining graphene and other nanomaterials such quantum dots and forming composite nanomaterials called nanocomposites. The number of possible nanocomposites that can be built from already existing nanostructures is simply enormous. A significant amount of research on exciton-plasmon interactions has been devoted to the study of QD-graphene nanocomposites, which offer a wide range of opportunities to control light-matter interactions and electromagnetic energy flows on nanometer length scales. Strong exciton-surface plasmon coupling in these nanocomposites could lead to efficient transmission of quantum information between qubits for applications in quantum computing and communication. These nanostructures also have applications in biophotonics and sensing, where nonradiative energy transfer between a QD and metal nanoparticle can be used to detect biological molecules. In this talk we study the Light matter interaction in nanocomposites and energy transfer between a QD and a graphene nanodisk. Here the QD-graphene system is embedded in a photonic crystal, which acts as a tunable photonic reservoir for the QD. Photonic crystals are engineered, periodically ordered microstructures that facilitate the trapping and control of light on the microscopic level. Applications for photonic crystals include all-optical microchips for optical information processing, optical communication networks, sensors and solar energy harvesting. In our investigation we consider a nonlinear photonic crystal, which has a refractive index distribution that can be tuned optically.

[1] M. Singh, Plasmonic, Photonic, Electronic and Polaritonic Materials (Wiley Custom, Toronto, 2014).
[2] M. Singh (Editor), Electronic, photonic, phononic and magnetic properties of nanomaterials (American Institute of Physics, New York, 2014)
[3] J. Cox, M. Singh, G. Gumbs, M. Antón & F. Carreño (2012), Phys. Rev. B 86, 125452 [10 pp].