Energy transfer between plasmon-enhanced up-converting α-$NaYF_4$:Er^{3+}/Yb^{3+} nanocrystals to graphene

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Abstract

Up-conversion in rare earth ions is a process, in which sequential absorption of two or more infrared photons leads to emission of light at wavelength shorter than the excitation wavelength. The luminescence of the emitters can be additionally enhanced when the emitter is close to a metallic nanoparticle. In particular, surface plasmons resonance improves light absorption and emission of the nanocrystals placed in a vicinity of silver nanowires. In this study, we investigated how graphene affects the up-conversion process in nanocrystals coupled with the metallic nanoparticles. Such structures are of interest as graphene can provide a platform for new applications in photovoltaic devices or various kind of sensors [1, 2].

In this work, we demonstrate the interplay between plasmon induced enhancement and graphene induced luminescence quenching of single α-$NaYF_4$:Er^{3+}/Yb^{3+} nanocrystals using fluorescence microscopy. The results show that in such a system nanocrystals exhibit quenching of the emission intensity due to energy transfer from nanocrystals to graphene and that the efficiency of the energy transfer depends on the emission wavelength and on the number of graphene layers. At the same time, the decrease in the luminescence intensity can be compensated by coupling the nanocrystals to metallic nanowires, with average of 7-fold increase in emission intensity with respect to the reference sample (Purcell effect) [3, 4]. By combining the two effects, we obtained fully operating system featuring efficient energy transfer from up-converting nanocrystals to graphene substrate at no expense in the overall luminescence intensity.

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References

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