Graphene Quantum Dots multiform morphologies of $NaYF_4:Gd^{3+}/Tb^{3+}$ phosphors and their optical properties

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Dimension and shape tunable architectures of inorganic crystals are of extreme interest due to modulation of the properties of materials. Recently, architectural manipulation progresses towards tailoring the influence of foreign atoms or impurities by selective incorporation in the reaction system, which can affect the phase, crystal growth and tune the shapes of crystals. For the first time, we present a novel impurity-driven strategy where we studied the influence of *in situ* of graphene quantum dots (GQDs) on the growth of phosphor crystals via hydrothermal route. The GQDs function as a nucleation site and by changing the concentration of GQDs, the morphology of phosphor was changed from rod to flower-like structure to disk-like structure, without phase transformation. The influence of size and functionalization of GQDs on the size and shape of phosphor crystals were also systematically studied. Plausible mechanisms of formation of multiform morphologies are proposed based on the heterogeneous nucleation and growth. Incorporation of two dimensional and one-dimensional carbon-based structures such as; graphene oxide (GO) and multi walled carbon nanotube (MWCNT), were also investigated. Most interestingly, the experimental results indicate that the photoluminescence properties of phosphor crystals are strongly dependent on the crystallite size and morphology. This study would be suggestive for the precisely controlled growth of inorganic crystals; consequently, it will open new avenues and thus may possess potential applications in the field of materials and biological sciences.