Supplementary Information

A Novel Strategy to Enhance the Luminescence Performance for NaGdF₄:Ln³⁺ Nanocrystals

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Figure S1 XRD patterns of NaGdF₄:Tb³⁺ (a) and NaGdF₄:Dy³⁺ (b) nanoparticles with and without modified of ligands. The standard card of β -NaGdF₄ (PDF#: 27-0699) was given as reference.



Figure S2 Size distribution for NaGdF₄: Eu^{3+} and NaGdF₄: Eu^{3+} -(BA)₃Phen nanoparticles obtained from the dynamic light scattering.



Figure S3 FT-IR spectral profiles for the pure $NaGdF_4:Eu^{3+}$ nanoparticles, $Tb(BA)_3Phen$, $Eu(BA)_3Phen$ complex, $NaGdF_4:Tb^{3+}$ and $NaGdF_4:Dy^{3+}$ nanoparticles with modified of BA and Phen ligands



Figure S4 Differential scanning calorimetry curve of the $NaGdF_4$:Eu³⁺ with modified of BA and Phen ligands



Figure S5 Fluorescent decay curves of the ${}^{5}D_{0}-{}^{7}F_{2}$ transition at 624 nm of Eu³⁺ ions in NaGdF₄:Eu³⁺ and NaGdF₄:Eu³⁺-(BA)₃Phen nanoparticles.



Figure S6 Mechanism of energy transfer processes in surface modified $NaGdF_4:Tb^{3+}$ and $NaGdF_4:Dy^{3+}$ nanoparticles



Figure S7 The photoluminescence emission spectra of the surface modified $NaGdF_4:Tb^{3+}$ (a) and $NaGdF_4:Dy^{3+}$ (b) nanoparticles at different temperatures



Figure S8 The temperature dependent photoluminescence intensity of the maximum emission peaks of functionalized NaGdF₄: Eu^{3+} , NaGdF₄: Tb^{3+} , and NaGdF₄: Dy^{3+} nanoparticles.