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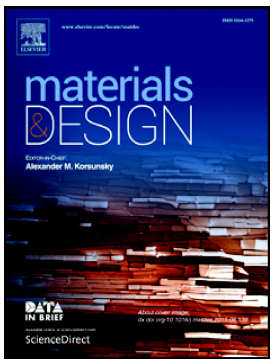

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Tunable green/red dual-mode luminescence via energy management in core-multishell nanoparticles

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Abstract

Achieving up-conversion luminescence from Tb^{3+}/Eu^{3+} ions was generally via a complicated energy transfer process (Yb^{3+}→Tm^{3+}→Gd^{3+}→Ln^{3+}, Ln=Tb/Eu), which makes the relevant energy management rather difficult and inevitably results in impure blue luminescence of Tm^{3+}. In this work, a facile and rational strategy is designed to integrate dual-mode luminescence from Eu^{3+}/Tb^{3+} ions into $NaGdF_4$:Yb/Eu@$NaGdF_4$:Ce@$NaGdF_4$:Yb/Tb@$NaYF_4$ core-multishell nanostructure. It is found that the down-conversion energy transfer across $NaGdF_4$@$NaGdF_4$ interface is confined in a narrow space region of approximately 2 nm. For the up-conversion mode, the primary factor that dominates the emission intensity of Eu^{3+} is determined to be the molar ratio of $NaGdF_4$:Yb/Tb component in the second shell to $NaGdF_4$:Yb/Eu one in the core, which differs from the anisotropic filtration effect previously reported. Eventually, tunable dual-mode emission colors were achieved through simply varying the inner shell thickness of $NaGdF_4$:Yb/Tb. The strategy of integrating dual-mode luminescence of Eu^{3+}/Tb^{3+} reported here for energy management allows one to design new luminescence materials for many important applications.

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