

Regulation of the luminescence efficiency of europium benzoates by –OH and –NO₂ substituents and alkali metal counterions.

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Streszczenie

Methods for the design of visible-light excitable europium nitrosalicylates having a high efficiency and “monochromaticity” of the luminescence are proposed. A series of europium-alkali metal 3,5-dinitrosalicylates and 5-nitrosalicylates with the general formula M₅Eu(Lig)₄·nH₂O (M = Li⁺, Na⁺, K⁺, Cs⁺), as well as 3-nitrosalicylates, was investigated using optical spectroscopy. The optimization of relative energies of the lowest excited singlet and triplet states of the ligands to achieve the best photophysical characteristics is provided by the proper arrangement of –OH and –NO₂ groups on the aromatic ring and a suitable choice of the counterion. The excitation energy transfer processes to the Eu³⁺ ion were analyzed. The effect of the triplets lying in close proximity to the 5D₀ state for 5- and 3-nitrosalicylates and to the 5D₁ state for 3,5-dinitrosalicylates on the Eu³⁺ luminescence efficiency was demonstrated. The europium-lithium 3,5-dinitrosalicylate has an optimum triplet position relative to the 5D₁ state to supply the most efficient energy transfer to the 5D₀ state of Eu³⁺ ion and the brightest red emission. The luminescence intensity of this compound exceeds that for the europium benzoate ~60 times at 77 K and ~25 times at 295 K. Thermal quenching properties of the compounds shown by the temperature behavior of the luminescence intensity and the 5D₀ lifetime are entirely similar. The proper combination of the sizes of the Ln³⁺ ion, ligand and counterion is necessary for the formation of a perfect structure of the complex with the most symmetrical Eu³⁺ luminescence center. It was found that the compound Li₅Eu(5-NSal)₄·4H₂O is characterized by an intense “monochromatic” red-light emission with the 7 cm^{–1} half-width for the 612.2 nm line related to the 5D₀–7F₂ transition.

Słowa kluczowe

Eu³⁺, Nitrosalicylate, Luminescence, Triplet state, Back energy transfer, Visible-light excitation

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