

Synthesis, Absorption and Photoluminescence Properties of the New Coordination Compound $\text{Eu}(\text{DBM})_3(\text{Ph}_3\text{PO})_1\text{H}_2\text{O}$

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Abstract: A new coordinate organic compound (COC) $\text{Eu}(\text{DBM})_3(\text{Ph}_3\text{PO})_1\text{H}_2\text{O}$ was synthesized and investigated (*DBM* stands for 1,3-Diphenyl-1,3-propanedione and *Ph₃PO* for triphenylphosphine oxide). The size of obtained $\text{Eu}(\text{DBM})_3(\text{Ph}_3\text{PO})_1\text{H}_2\text{O}$ powder nanocrystals is around 50 nm. Under ultraviolet light excitation, the material exhibits an abundant and pure red color photoluminescence (PL). The PL spectrum measured in the range of 500 - 750 nm has a number of narrow (atomic) emission lines with FWHM less than 10 nm, which are assigned to the energy transitions $^5\text{D}_0 \rightarrow ^7\text{F}_i$ ($i = 0, 1, 2, 3, 4$) in the $4f$ - shell of the Eu^{3+} ion. PL experimental results and its kinetics were analyzed using the theory of Judd-Ofelt's parametric method and the characteristic parameters were obtained: the lifetime τ , quantum efficiency η , and transitions probability of electrical dipoles A_{ij} .

1. INTRODUCTION

Coordinating compounds with rare earths are extensively studied due to their diverse chemical structure and unique physical properties with potential for application in various fields such as optical materials, lasers, photovoltaics, etc. The electronic transitions in the within the $4f$ shell of the Eu^{3+} ion are forbidden because of its spherical symmetry. Ligand molecules in Eu^{3+} compounds form the electric field that distorts the spherical symmetry and as a result the transitions within the electronic shell $4f$ become allowed. The coordinating compounds of rare earths exhibit luminescent properties due to the specific configuration of the $4f$ orbital of the rare earth ions, which is the reason that rare earth COC exhibit strong luminescent properties.

For this, Eu^{3+} compatible ligands are required to obtain Eu^{3+} luminescent coordinating compounds in which light absorption takes place in ligands with subsequent energy transfer from the excited states of the ligands to the energy states of the Eu^{3+} ion. Ion-based coordination compounds have a long-lasting emission in the visible domain that facilitates their application in medicine, biology, photovoltaics, etc.¹⁻⁴ Among the most useful categories of compounds for use in these applications are beta-diketones of rare earths, which have luminous efficiency, volatility, which makes them simple to apply in thin films and provide a wide possibility of changing their physical properties. Due to the low capacity of $\text{Eu}(\text{III})$ forms of stable complexes based on $\text{Eu}(\text{III})$ is possible only with polydentate chelating ligands. Consequently, by using different organic, neutral and beta-diketone ligands, complexes with higher luminescence can be obtained.

Commonly the rare earth ions exhibit low emission efficiency under light excitation. Eu^{3+} ions at light absorption show low PL efficiency. The direct excitation of the Eu^{3+} ion is negligible, because low absorption cross-section of the ion the $4f$ shell of the Eu^{3+} ion is shielded by sealed and completed higher energy levels $5s^2$ and $5p^6$. This leads to the insignificant influence of the outer crystalline environment of the coordinating compound on the transitions from $4f$ shell within the Eu^{3+} ion. Enhancement of PL emission in coordinating compounds is commonly attributed to the process of energy transfer from excited organic ligands to rare earth ions, which finally results to enhancement of the PL emission.