Multicolour PHB and PMMA Luminescent Films Doped with $[Eu(tta)_3(tppo)_2]$ and $[Tb(acac)_3(tppo)_2]$ Complexes

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Summary

PHB and PMMA polymer films doped with $[Eu(tta)_3(tppo)_2]$ and $[Tb(acac)_3(tppo)_2]$ complex precursors were prepared and characterised by XRD, FT-IR, TGA, MEV and AFM. Their photoluminescence properties are reported based on the excitation and emission spectra.

Keyword

Photoluminescence, Multicolour, Lanthanide Complexes, Polymer Films

Introduction

Over the past three decades, trivalent Rare Earth (RE^{3+}) β-diketonate complexes have attracted much attention due to their intrinsic spectroscopic properties and applications as luminescent materials [1]. However, the Ln^{3+}-complexes generally present low thermal stability, limited photostability and poor mechanical properties. In order to overcome simultaneously these deficiencies and improve the characteristics of light emission (*e.g.* quantum yield, lifetimes), RE^{3+}-complexes have been incorporated into organic polymers, liquid crystals and sol-gel derived organic-inorganic hybrids [2]. Polymers offer several advantages for the development of materials, such as: flexibility, versatility, optical quality and moderate processing conditions. By incorporating luminescent Ln^{3+}-complexes within the polymer matrix, the resulting product represents not only the sum of individual contributions of both organic and inorganic phases, but also novel properties for a new class of materials [3].

The poly(methylmethacrylate) polymer (PMMA) exhibits excellent mechanical and optical properties that favour its application as the basis for optical devices [4]. The poly(hydroxybutyrate) (PHB) is a polymer which has similar physical properties to polypropylene (PP), suggesting its potential applications as wrappings, containers, plastic mouldings, etc. In addition, PHB is an environment friendly material owing to its biodegradable properties which make it an advantageous material as the host structure in luminescent materials [5]. Furthermore, these polymers contain carbonyl groups along with its carbon-chain that can interact with Ln^{3+} ions. Hence, improvement in the overall physical and chemical properties and enhancement of the luminescence properties can be expected with polymer films based on PMMA and PHB doped with Ln^{3+}-β-diketonate complexes.

Results and Discussion

The CHN, FT-IR, XRD and TGA analysis confirmed the general formula of $[RE(L)_3(tppo)_2]$ (RE: Eu and Tb; L: tta and acac) complex precursors and their successful incorporation into the PHB and PMMA polymers. The luminescent films were obtained by the Spilling Method. Studies of the surface morphology of the polymer systems were conducted by SEM and AFM. Photoluminescence properties were investigated based on the spectroscopic data obtained for the complexes and polymer films. It is observed in the excitation and emission spectra of the polymeric luminescent systems narrow bands originated from the characteristic intraconfigurational 4f-4f transitions, indicating efficient intramolecular energy transfer from the organic moiety to the RE^{3+} ions. Particularly, the β-diketonate ligands act as effective sensitizers of the luminescent centres and the resulting polymeric films doped with Eu^{3+}- and Tb^{3+}-complexes present strong monochromatic red (614 nm) and green (546 nm) emissions, respectively. The emission quantum efficiencies and experimental intensity parameters of the $^5D_0$ emitting energy level of Eu^{3+} ions both for the complex precursors and the polymer films were also determined.

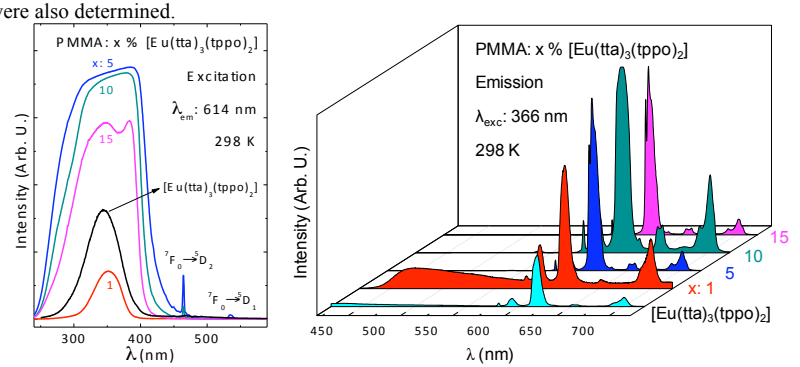

Figure 1: Excitation (left) and emission (right) spectra of PMMA:$[Eu(tta)_3(TPPO)_2]$ films.

Conclusions

PHB and PMMA were incorporated with $Eu(tta)_3(tppo)_2]$ and $[Tb(acac)_3(tppo)_2]$ complexes, yielding highly luminescent polymeric thin films. The polymeric matrices not only immobilize the luminescent RE^{3+} species, but also act as co-sensitizer and enhance the characteristic monochromatic emissions arising from the 4f–4f intraconfigurational transitions of the RE^{3+} ions. Therefore, they are suitable for the production of advanced photonic applications such as multicolour optical markers, anti-falsification inks, UV sensors, etc.

References

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