11th International Conference on Advanced Materials
ICAM 2009
Rio de Janeiro Brazil
September 20 - 25

Color tuning systems of polymer doped with rare earth complexes

J. Kai(1), R. Stefani(1), M. C. F. C. Felinto(2) and H. F. Brito(1)*

(1) Instituto de Química, Universidade de São Paulo, Brasil, e-mail: kaijiang@iq.usp.br
(2) Centro de Química e Meio Ambiente, Instituto de Pesquisas Energéticas e Nucleares, Brasil
* Corresponding author.

Abstract – Rare earth complexes were synthesized and doped into polymers resulting in luminescent films. The obtained systems were characterized with elemental analysis, IR, TGA/DTG and XRD techniques. Photoluminescence properties were investigated and processes of energy transfer and sensitization were studied. Monochromatic emissions of obtained polymeric systems enabled their potential applications in multicolor displays because of the primary colors emitted by TR^{3+}: red (Sm^{3+} and Eu^{3+}), blue (Gd^{3+}) and green (Tb^{3+}). The polymer matrix performs an essential role in the luminescent sensitization processes for systems containing Sm^{3+}, Eu^{3+}, Gd^{3+} and Tb^{3+}, therefore the overall systems act as Light Conversion Molecular Devices (LCMDs).

The rare earth complexes exhibit characteristic narrow emission bands in the UV-Vis region, large Stokes shift and the sensitizing effect that enhance the overall quantum efficiency. As a result, these complexes have found wide applications as luminescent markers, photoluminescent sensors, electroluminescence devices and multicolor displays [1]. However, important issues have to be addressed since most of these complexes present low thermal stability, photo-sensitivity and poor mechanical properties. These are inevitable challenges to the researcher communities in the world relating to the applicability of rare earth complexes in some areas such as illuminations, sensors, displays etc. [2].

To overcome these disadvantages simultaneously, luminescent materials based on β-diketonate RE^{3+}–complexes doped polymers have attracted considerable interests over the last few decades [3]. In this work, we report the synthesis, characterization and luminescent properties of polymethylmetacrylate (PMMA) doped with Sm^{3+}, Eu^{3+}, Gd^{3+} and Tb^{3+} complexes. By incorporating rare-earth luminescent species into the polymer matrix, not only the properties of these new materials represent the sum of individual contributions of both organic and inorganic phases, the polymer matrices also serve as co–sensitizers that enhance the characteristic monochromatic emission arising from intraconfigurational 4f-4f transitions of RE^{3+}.

The emission spectra of RE^{3+}–complexes doped PMMA films showed characteristic emission bands arising from intraconfigurational transitions of the ions: Sm^{3+} ($^4G_{5/2}\rightarrow{}^6H_{5/2,-11/2}$), Eu^{3+} ($^5D_0\rightarrow{}^7F_J$, J = 0–6) and Tb^{3+} ($^5D_4\rightarrow{}^7F_J$, J = 6–0), emitting orange–red, red and green color, respectively. Gd^{3+} doped PMMA films exhibited intense green luminescence at room temperature (298 K), except for the blue–color emitting PMMA:$Gd(Hsal)_3$ systems. Particularly, emission bands arising from the $^5D_0\rightarrow{}^7F_{0-4}$ transitions of Eu^{3+} doped films were dominated by the hypersensitive $^5D_0\rightarrow{}^7F_2$ transition (~612 nm), indicating that the Eu^{3+} ion is found in a noncentrosymmetric chemical environment. Furthermore, high Ω_2 values obtained for PMMA:Eu^{3+} systems suggested that RE^{3+} ions are located in a more polarizable chemical environment.

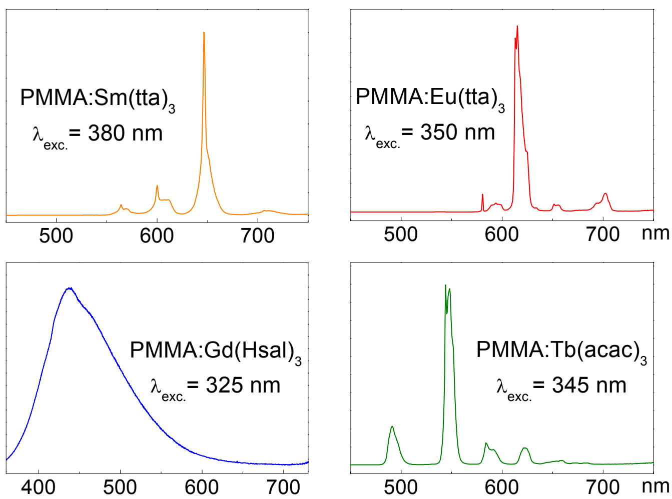

Figure 1: Emission spectra of PMMA films doped with TR^{3+}–complex

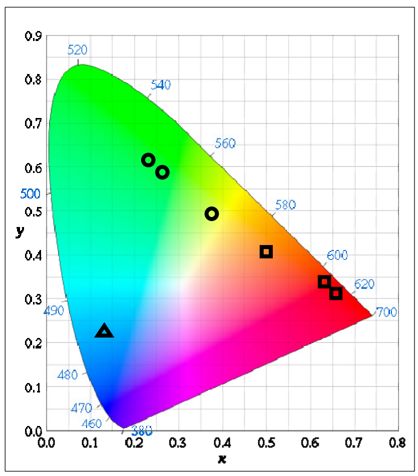

Figure 2: CIE Diagram of PMMA:TR^{3+}–complex

[1] H.F. Brito, O.L. Malta, M.C.F.C. Felinto and E.E.S. Teotonio, “Luminescence phenomena involving metal enolates” in The Chemistry of Metal Enolates, ed. J. Zabicky, chapter 3, John Willey & Sons Ltd., (2009) 131–184.
[2] L.D. Carlos, R.A.S. Ferreira, V.D. Bermudez and S.J.L. Ribeiro, Adv. Mater. 21 (2009) 509–534.
[3] J. Kai, D.F. Parra and H.F. Brito, J. Mater. Chem. 18 (2008) 4549–4554.