# Structural and Luminescent properties of Europium benzene-1,3,5tricarboxylate

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# ABSTRACT

The increasing demand of optoelectronic devices requires the development of luminescent materials with high luminescence quantum efficiency and reduced energy consumption, to this organic matrix materials doped with rare earths offer an great alternative. The organic matrix materials also provide flexibility properties, low density, low economical methods of synthesis that increase the advantage from these materials to the traditional synthesis with phosphors. In this paper benzenetricarboxylate ligand doping with europium ion was synthesized and this structural and luminescent properties were measured, the formation of this metalorganic compound was generated through chemical synthesis from europium nitrate and benzene 1,3,5 -tricarboxylate acid precursors. Through the characterization by X-ray diffraction powder (XRD), infrared spectroscopy, SEM structural characterization, and luminescent spectroscopy the good incorporation of Europium was tested and a red luminescent emission with a high quantum efficiency was observed.

*Keywords*: metal organic frameworks, luminescence, europium, BTC-Eu.

# **1 INTRODUCTION**

Metal-organic complexes are a new class of hybrid materials built from metal ions with well-defined coordination geometry and organic bridging ligands which have already shown potential applications in gas storage, catalysis, sensors, nonlinear optics, and molecular recognition. [1], [2], [3]. Lanthanide compound nanocrystals are currently under vigorous investigation due to their prospective usage in many areas such as optoelectronics, display devices, up-conversion phosphors [4], [5] A little attention has been paid to the preparation of hierarchically ordered, branched architectures of rare earth organic complexes although they can be applied in a variety of areas such as light conversion materials, organic electroluminescent devices, optical microcavity emitters, etc. It is for that reason that the synthesis of metal-organic frameworks (MOFs) are of great current interest. MOFs may be defined as supramolecular solids that consist of "strong bonding providing robustness, linking units that are available for modification by organic synthesis, and a geometrically well-defined structure [6]. The latter property

further implies that these solids should be highly crystalline.

Recently, 4f and 5f metal coordination compounds have attracted increasing attention due to their interesting properties of photoluminescence [7]. Lanthanide (4f) complexes usually exhibit intense luminescence and are potentially applicable for the manufacture of fluorescent probes and electroluminescent devices. The efficiency of ligand absorption in the UV region, ligand-to-metal energy transfer and rare earth luminescence play an important role in determining luminescence intensity [8]. Therefore, it is significant to esign and synthesis the ligand, whose triplet energy level matches better to the emitting level of the rare earth ions.

#### **2** EXPERIMENTAL SECTION

The quantity of 3.0 mmol of benzene-1,3,5-tricarboxylic acid (BTC, 95% purity, Aldrich) was dissolved in 150 mL of distilled water. Second solution prepared with 3.0 mmol of europium nitrate hexahidrated (99.99% grade, Aldrich) in 40 mL of ethanol anhydrous was gradually added to the organic solution. The synthetic mixture was stirring at room temperature during 12 h. The resulting product was isolated by centrifugation and dried at 323 K for 2 h. Solids and liquids were stored for further characterization. The MOFs were characterized by X-ray diffraction (XRD) analysisXray diffraction patterns were obtained at room temperature on a powder diffractometer (Bruker D8Advance) using Cu K $\alpha$  radiation (1.5418 Å). In order to inspect the morphology and sizes of the samples, conventional Scanning Electron Microscopy was carried out on a JEM-2200FS operating at 80 keV. The photoluminescent properties were recorded employing a Hitachi F700 spectrophotometer.

# **3 RESULTS AND DISCUSION**

The X-ray diffraction patterns of BTC-Eu is shown in Figure 1. Peaks can be well indexed to a known bulk phase of La(1,3,5–BTC)6H2O as Kai Liu et al can founded as isostructural [1] showing that the shift can be explained for the ionic radii change. The average cell parameter of the MOF is is 26.13 Å and crystal size of 292 nm. The patten shows two importan peaks at 14 and 18  $^{\circ}$  suggesting that the powders are well crystallized.



Figure 1. XRD of BTC-Eu.

The details of morphological features of the BTC-Eu are shown in Figure 2. As can be seen the powders are well organized with nanowire architectues. Besides, the images suggests that the growing begins from a rhombic shape. The size of the rhombic is about 200 nm.



Figure 2. SEM micrograph of the MOF BTC-Eu for two diferent zones a) and b) in where the rhombic shape of nanowires was observed.

The luminiscent characterization was performed and the excitation and emission spectrum with enhaced peaks was obtained for the MOF BTC-Eu. The figure 4 shown the spectrum in where an a maximum excitation of the charge transfer band at 283 nm (solid line) and the f-f transitions wavelengths at 362, 379, 395 nm can be observed. In the emission wavelenghts the strongest emission peak was presented at 618 nm wich corresponds to the  ${}^{5}D_{0} \rightarrow {}^{7}F_{2}$  transition  $Eu^{3+}$ . of the But the transitions  ${}^{5}D_{0} \rightarrow {}^{7}F_{I}$  (J = 1, 2 and 4) located at 590, 612, and 697 nm of the europium can be observed in the MOF with high intensity, the transition  ${}^5D_0$  to  ${}^7F_3$  was not The ratio  $R = I({}^{5}D_{0} \rightarrow {}^{7}F_{2})/I({}^{5}D_{0} \rightarrow {}^{7}F_{1})$ presented. emission intensity which is used for meassured the coordination state and site symmetry 7.4 was an a value bigger that the value normaly reported [9]. This means that with the incorporation of the europium in an organic ligand as benzenetricarboxylate an a transfer energy can be presented in order to increase the luminescent phenomena.



Figure 3. Normalized PL emission spectrum for the MOF BTC-Eu

As is shown in the Figure 4 the CIE coordinate of the sample was (0.647, 0.351), shifted to the red region as a result of the dominant red peak centrered at 616 nm.



Figure 4. CIE coordinate for the MOF BTC-Eu in the red region of color.

#### **5** CONCLUSIONS

We have successfully introduced an one-step approach to self-assemble the metal–organic framework Eu-BTC with nanorhombic morphologies.

The Eu-BTC powders were crystallized at room temperature. Besides, the powders shown intense luminescence in the red range when excited at 283 nm.

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