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Persistent luminescence $BaAl_2O_4:Eu^{2+},Dy^{3+}$ phosphor incorporated in silica: water resistance

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Abstract – Barium aluminates doped with divalent europium and trivalent dysprosium were prepared with the combustion method and then incorporated with silica using the microemulsion method. The incorporated phosphor particles showed improved water resistance, preserving much of the prior persistent luminescence properties even after interaction with water whereas the non-incorporated particles loosed the original persistent luminescence. The infrared absorption spectroscopy, X-ray powder diffraction (XRD), scanning electron microscopy (SEM) and photoluminescence studies were used to characterize the phosphors. The pH of the phosphor-water mixture after the reaction with water was measured to compare the water resistance of the materials. The photoluminescence of the incorporated $BaAl_2O_4:Eu^{2+},Dy^{3+}$ with water modified slightly the $4f^65d^1 \rightarrow 4f^7$ transition of Eu^{2+}, however.

The persistent luminescence materials have attracted a lot of attention in recent years owing to their potential practical applications [1]. The $BaAl_2O_4:Eu^{2+},Dy^{3+}$ material has proved to be a promising persistent phosphor, since the preparation needs no special atmosphere to reduce the trivalent europium [2]. However, this material has only weak resistance to water and when hydrolyzed, it looses much of the persistent emission [3]. To improve the resistance to water, the protection of the phosphor particles is necessary.

In this work, the $BaAl_2O_4:Eu^{2+},Dy^{3+}$ phosphors were prepared with the combustion method using urea as the fuel and the metal nitrates as the reactants. All the precursors were solved into the least amount of distilled water. A capsule filled with the solution was inserted into a furnace pre-heated at a temperature between 400 and 600 °C. After the reaction, the phosphor particles were coated with silica using the microemulsion method with TEOS as the silica source and Triton X-100 as the surfactant. The water resistance of the materials was tested by adding distilled water and heating the mixture at 60 °C for five minutes. The XRD indicated always the presence of the hexagonal barium aluminate phase.

The unprotected phosphor treated with water presents one broad emission band at 440 nm (Fig. 1) with no persistent luminescence at 298 K. Instead, the incorporated material shows two broad bands at 440 and 504 nm exhibiting also strong persistent luminescence. A change in the emission color of the phosphors could also be observed (Fig. 2) due to the action of water. According to the emission characteristics, the silica encapsulation seems to offer only partial protection, however.

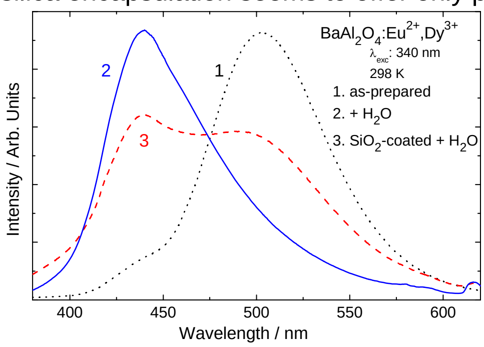

Figure 1: The emission spectra of the $BaAl_2O_4:Eu^{2+},Dy^{3+}$ phosphors with UV excitation at 340 nm.

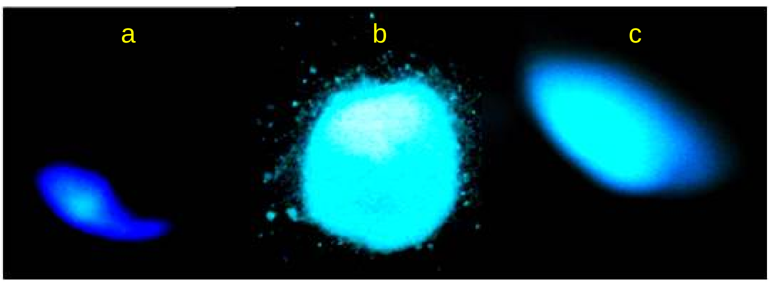

Figure 2: Emission characteristics of different $BaAl_2O_4:Eu^{2+},Dy^{3+}$ phosphors under UV excitation: a) after water treatment, b) dry phosphor, c) after water treatment of the incorporated phosphor.

References

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