Persistent luminescence in rare earth doped oxynitrides

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In 1996, $SrAl_2O_4:Eu^{2+}$ codoped with Dy^{3+} ions was developed as an efficient persistent luminescent material with a very long afterglow [1]. This fact, combined with global efforts to reduce energy consumption of light sources, has led to a renewed interest in the class of long persistent luminescent materials. However, large scale application in safety illumination, emergency and road signage, … is hampered by the limited number of different colors available, especially in the long wavelength part of the visible spectrum. Therefore, the quest for phosphors with better specifications and different emission spectra is still open.

In the present work, the oxynitrides of the family $MSi_2O_2N_2:Eu$ (M = Ca, Sr, Ba) were synthesized using high temperature solid state reaction (3 h at 1400 °C). Without codoping, only $BaSi_2O_2N_2:Eu$ shows persistent luminescence, with a broad blue-green emission peak around 495 nm. This is similar to the steady state photoluminescence spectrum, showing that Eu^{2+} is indeed acting as the recombination center. Thermoluminescence emission and excitation spectroscopy was performed, which showed the presence of two different recombination centers (with slightly different emission spectrum), in spite of the reported single crystallographic site for Eu^{2+}.

Until now, most of the materials that show persistent luminescence fall into two main categories, the aluminates and the silicates. Investigating persistent luminescence in oxynitrides can thus be very interesting to help us understand the exact mechanism of the phenomena [2]. In order to gain a better understanding of the why and how of persistent luminescence in this class of materials, the structure of the host compound was investigated in detail, as a function of the synthesis conditions, and related to the luminescent properties. This information is particularly useful to find out whether there are different possible sites for the Eu-ions in the oxynitride lattice. In addition, the effect of Eu dopant concentration and codopants was studied.

While there is still room for improvement and further research on these oxynitrides, they are serious candidates for practical applications in persistent luminescence.

[1] Matsuzawa T., Aoki Y., Takeuchi N., Murayama Y., A new long phosphorescent phosphor with high brightness, $SrAl_2O_4:Eu^{2+},Dy^{3+}$, J. Electrochem. Soc. **143**, 2670-2673 (1996)

[2] Van den Eeckhout K., Smet P.F., Poelman D., Persistent luminescence in Eu^{2+}-doped compounds: a review, Materials (submitted).