

# Persistent luminescence and mechanoluminescence in $\text{BaSi}_2\text{O}_2\text{N}_2:\text{Eu}$

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Europium doped oxynitrides with composition  $\text{MSi}_2\text{O}_2\text{N}_2:\text{Eu}^{2+}$  (M = Ca, Sr or Ba) have recently been proposed as excellent conversion phosphor materials for white-light-emitting LED applications based on near ultraviolet (UV) or blue emitting InGaN LEDs. They not only show a strong absorption in the near UV to blue-light region of the light spectrum, but also have high quantum efficiency and good thermal and chemical stability compared to oxide and sulphide phosphors [1, 2].

All three  $\text{MSi}_2\text{O}_2\text{N}_2:\text{Eu}^{2+}$  compounds show persistent luminescence, i.e. the light emission continues after excitation of the material has been stopped, but the brightness and the duration of the persistent luminescence is strongly dependent on the host material and the wavelength at which the phosphors are excited. Persistent luminescence is a disadvantage when it comes to applying the materials in a phosphor converted white LED. It was shown that the  $\text{SrSi}_2\text{O}_2\text{N}_2:\text{Eu}^{2+}$  and  $\text{CaSi}_2\text{O}_2\text{N}_2:\text{Eu}^{2+}$  compounds are suitable conversion phosphors in combination with a blue pumping LED because excitation with light in this wavelength range ( $400 \text{ nm} < \lambda < 500 \text{ nm}$ ) does not result in bright afterglow. For  $\text{BaSi}_2\text{O}_2\text{N}_2:\text{Eu}^{2+}$  persistent luminescence can be induced by exciting the phosphor with light in a broad wavelength range ( $250 \text{ nm} < \lambda < 500 \text{ nm}$ ) [3].

Next to its persistent luminescent property,  $\text{BaSi}_2\text{O}_2\text{N}_2:\text{Eu}^{2+}$  shows strong luminescence upon mechanical stimulation such as friction or pressure. This phenomenon, known as non destructive mechanoluminescence (ML), is not so common and can be applied in pressure sensing devices. Many similarities are observed between the ML and the persistent luminescence in  $\text{BaSi}_2\text{O}_2\text{N}_2:\text{Eu}^{2+}$ . E.g. ML and persistent luminescence emission spectra are identical and show a shift towards longer wavelengths of about 4 nm compared to the photoluminescence (PL) emission spectrum. This suggests that the radiative recombination path is the same for the mechanoluminescence and the persistent luminescence.

Based on the observed ML properties of the phosphor, in combination with information extracted from thermoluminescence excitation spectroscopy measurements, the trap release mechanism is modeled and an energy level scheme for the persistent luminescence and ML in  $\text{BaSi}_2\text{O}_2\text{N}_2:\text{Eu}^{2+}$  is proposed.

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