New generation of aluminium borate phosphors for white leds lighting prepared by "chimie douce"

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NEW GENERATION OF ALUMINIUM BORATE PHOSPHORS FOR WHITE LEDS LIGHTING PREPARED BY "CHIMIE DOUCE"

Mathieu Salaün[1], Jeremy Cathalan[1,3], Vincent Maurel[2], Didier Gasparutto[2], Christine Saint-Pierre[2], Isabelle Gautier-Luneau[1], Alain Ibanez[1], Audrey Potdevin[3] and Geneviève Chadeyron[3]

[1] Université Grenoble Alpes, Institut NEEL, F-38042 Grenoble, France; [2]Université Grenoble Alpes, CEA, CNRS, IRIG, SyMMES, F-38000 Grenoble, France, [3]Université Clermont Auvergne, Clermont Auvergne INP, CNRS, Institut de Chimie de Clermont-Ferrand, Clermont-Ferrand, France

ABSTRACT:

Devices using light-emitting diodes (LEDs) represent a breakthrough in the lighting and display markets, allowing a significant reduction in their energy requirements. These devices generally consist of a blue LED (GaN p-n junction + InGaN quantum wells) and the yellow YAG phosphor: Ce^{3+} (cerium-doped yttrium aluminium garnet). The latter partially absorbs the blue radiation of the LED and generates a yellow emission leading to an overall white lighting. However, this technology is giving rise to environmental, economic and geopolitical problems, which justify the search for alternative materials and processes for the realisation of new LED architectures. In previous works [1], we presented the synthesis by soft chemistry (modified Pechini and sol-gel methods) of amorphous aluminium borate powders. These aluminium borate powders, derived from non-toxic precursors and made up of abundant elements, exhibit white and efficient photoluminescence (PL) emission when excited by near-UV radiation (Figure 1). Thermal analyses (DTA, TG) coupled with mass spectrometry of the decomposition gases, have shown a correlation between the PL properties and mass losses of a few hundred ppm during the crystallisation of these phosphor powders around 800°C. This allowed us to establish that these mass losses were of organic origin. This allowed us to establish that these mass losses were of organic origin. At the same time [2], we demonstrated by EPR and NMR spectroscopies the formation of luminescent Polycyclic Aromatic Hydrocarbons (PAHs) molecules during calcination. This hypothesis is in good agreement with the short PL lifetime of a few ns [3], which correspond to a typical fluorescence of molecular phosphors. Finally, ongoing chromatographic studies should allow us to specify the type of PAH molecules. From all these observations, we assume that PAH molecules are generated from the decomposition of organic precursors, concomitantly with the formation of the aluminium borate matrix during thermal treatments (around 500-700°C).

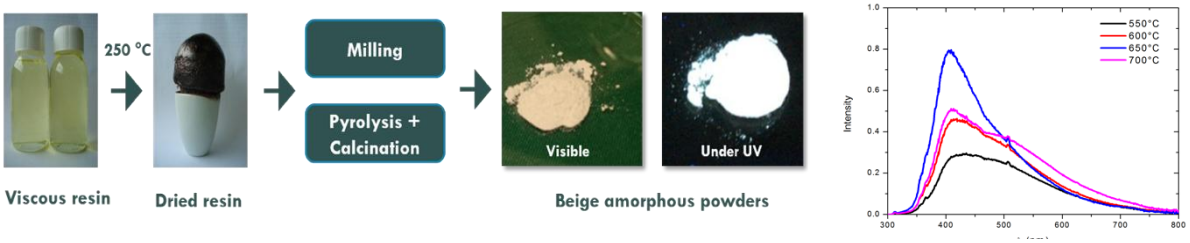

Figure 1 :The step process: resin, after drying at 250°C, pyrolysed black powder and luminescent powder after a final calcination. Broad tunable PL emission of the phosphor from 450 to 800 nm (exc. 385 nm).

References

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