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"UV or blue LEDs with phosphors: An interesting way to develop smart lighting."

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White light emitting diodes (WLEDs) have reached efficiencies which should allow them to be candidates as light sources of the future for domestic indoor lighting. Today, the WLEDs are considered as one of the most promising eco-friendly light sources, not containing mercury and more energy efficient than conventional lighting devices (incandescent and compact fluorescent light bulbs). Indeed, in most WLEDs, rare-earths doped oxides are used as light converting materials in a single diode chip to obtain the targeted emission [1–3]. Current commercial WLEDs use a 460 nm blue GaN LED chip covered by a $Y_3Al_5O_{12}:Ce^{3+}$ (YAG:Ce) yellowish phosphor coating. However, this association suffers from some weaknesses such as a poor color rendering index (CRI) and a low stability of color temperature. Actually, in such a device, the deterioration of the chip or YAG:Ce phosphor can imply some significant color changes especially because the blue LED emission participate for generating the white light. Moreover, a too cold color temperature for indoor domestic lighting is reached due to a lack of red contribution. These drawbacks prevent this association "blue LED/phosphor" from penetrating the general public lighting market and in particular highly valued indoor domestic lighting which requires a CRI better than 90, a color temperature comprised between 3000 and 4000 K with a luminous efficiency superior or equal to 150 lumen per watts.[2,4,5]. Combining deep-ultraviolet (DUV – 200 nm $\leq \lambda_{em} \leq$ 300 nm) or ultraviolet (UV – 300 nm $\leq \lambda_{em} \leq$ 400 nm) diode chips with a mixture of red, green and blue phosphors to produce white light appears as a promising alternative with several advantages. One of the key points of this type of association is the invisible emission of the LED chip.[2] These devices could conquer a large panel of applications notably because they give access to a wide range of colors and controlled CRI. For instance, they can be used from domestic to professional, indoor or outdoor lighting but also for mood lighting or safety marking. As an indication, the trade in bakery stands needs warm lights (color temperatures lying from 2700 to 3000 K) whereas for meats, fruits, vegetables or milk products, a neutral color (between 4000 and 5000 K) is more desirable and for seafood products a colder color seems better.[6]

The versatility of the association "UV LED/phosphors" is due to the possibility to play on phosphors formulation, a lot of phosphors being suitable with such an excitation, as well as on phosphors ratios used in this device. However, at this stage, according to the lighting market suppliers, the success of this association must go through an improvement of UV LEDs technology, especially DUV LEDs which presently exhibit inadequate performances.[7–10]

In this talk, I will show you the potentialities of application of phosphors synthesized by soft chemistry in lighting devices based on each kind of LED/phosphors association. In particular, the synthesis and shaping of a red phosphor, $Y_3BO_6:Eu^{3+}$ will be presented; this study was chosen to illustrate the interest in using soft chemistry processes for obtaining efficient phosphors. Conventionally, phosphors used in WLEDs devices are obtained via an energy consuming solid state reaction process requiring a several hour heating treatment at high temperatures and leading to large size and irregular shapes.[11] To avoid these drawbacks, researches aiming at the improvement of usual phosphors focus on new synthesis methods resulting in powders with a narrow distribution of grains size and/or allowing the shaping of the materials as homogeneous films suitable for lighting devices.

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