Scientists fabricate novel ternary ceramic phosphor for warm white-LEDs

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By efficiently converting the blue light emitted from InGaN chips into yellow light and mixing them into white light, classic yellow $Y_3Al_5O_{12}$: Ce (YAG) phosphor has proved itself to be the most prominent phosphor in white light emitting diodes (w-LEDs). However, the color rendering index (CRI) of YAG: Ce-based w-LEDs is usually limited to

To improve the light quality and enhance the luminous efficiency (LE) of YAG: Ce phosphor, a research team from the Shanghai Institute of Optics and Fine Mechanics of the Chinese Academy of Science has fabricated a novel ternary ZrO_2-Al_2O_3-YAG: Ce composite ceramic phosphors recently.

After packaged with blue chips, the w-LED based on ZA-YAG: Ce ceramic shows an enhanced CRI of 64 compared to Al_2O_3-YAG: Ce and a high LE of 92.36 lm/W, which is greatly promoted compared to the previous report of ZrO_2-YAG: Ce. The result was published in *Journal of the European Ceramic Society*.

In their experiment, commercial Y_2O_3, α-Al_2O_3, CeO_2, ZrO_2 powders were used as raw materials. The powders were weighted according to the formula and fully mixed. After ball milling in ethanol for 24 hours, the slurry was dried at 75 degrees C and granulated with a 200-mesh sieve.

After pressed into disks under uniaxial pressure of 10 MPa, the disks were processed under cold isostatic pressing at 200 MPa. The pressed disks were then heated in a muffle oven at 700 degrees C for three hours

to remove the organic ingredients. Finally, the phosphor ceramic samples were obtained after sintered at the temperature of 1,650-1,700 degrees C for 12 hours, respectively.

From the microstructure evolution, the researchers found that the addition of ZrO_2 can remarkably promote the densification process of samples. From the EDS analysis result, they discovered that the three phases of ZrO_2, Al_2O_3, and YAG can co-exist with each other independently after sintering although Y in YAG and Zr in ZrO_2 can exchange to a certain extent.

More information: Jie Chen et al. Fabrication of ternary ZrO2-Al2O3-YAG:Ce ceramic phosphors for white light-emitting diodes, *Journal of the European Ceramic Society* (2020). DOI: 10.1016/j.jeurceramsoc.2020.10.027

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