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Synthesis of Nano-Sized Y3Al5O12:Ce3+ Phosphors Prepared by High Energy Beads Milling Process and Their Luminescence Properties

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For white light emitting diode (LED) applications, it has been reported that Y3Al5O12:Ce3+ (YAG:Ce) in nano-sized phosphor performs better than it does in micro-sized particles. This is because nano-sized YAG:Ce can reduce internal light scattering when coated onto a blue LED surface. Recently, there have been many reports on the synthesis of nano-sized YAG particles using bottom-up method, such as co-precipitation method, sol-gel process, hydrothermal method, solvothermal method, and glycothermal method. However, there has been no report using top-down method. Top-down method has advantages than bottom-up method, such as large scale production and easy control of doping concentration and particle size. Therefore, in this study, nano-sized YAG:Ce phosphors were synthesized by a high energy beads milling process with varying beads size, milling time and milling steps. The beads milling process was performed by Laboratory Mill MINICER with ZrO2 beads. The phase identity and morphology of nano-sized YAG:Ce were characterized by X-ray powder diffraction (XRD) and field-emission scanning electron microscopy (FESEM), respectively. By controlling beads size, milling time and milling steps, we synthesized a size-tunable and uniform nano-sized YAG:Ce phosphors which average diameters were 100, 85 and 40 nm, respectively. After milling, there was no impurity and all of the peaks were in good agreement with YAG (JCPDS No. 33-0040). Luminescence and quantum efficiency (QE) of nano-sized YAG:Ce phosphors were measured by fluorescence spectrometer and QE measuring instrument, respectively. The synthesized YAG:Ce absorbed light efficiently in the visible region of 400-500 nm, and showed single broadband emission peaked at 550 nm with 50% of QE. As a result, by considering above results, high energy beads milling process could be a facile and reproducible synthesis method for nano-sized YAG:Ce phosphors.

Keywords: Y3Al5O12:Ce, YAG, nano phosphor, high energy milling, top-down