YAG phosphor with spacial separated luminescence centers

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Experimental details

In a typical synthetic procedure for colloidal precursor particles, proper amount of $Y(NO_3)_3 \cdot 6H_2O$, $Al(NO_3)_3 \cdot 9H_2O$ (Alfa Aesar, 99.99%), and urea (Sinopharm Chemical Reagent Co., Ltd, Specpure) were dissolved in distilled water to make transparent solution. Commercial YAG:Ce phosphor particles were applied as the introduced second phase in a urea precipitation process. In all cases, the concentration of Y^{3+} was kept at 0.015 M, the concentration of Al^{3+} was kept at 0.025 M, while urea was kept at 1 M. Doping level of Cr^{3+} was kept at 0.5% the concentration of Al^{3+}. The mixed solution was homogenized and then heated to 90 ^{o}C for 2h. Rigorous stirring is necessary for the homogeneous precipitation process. Resultant precursor was recovered via suction filtration. Byproducts of the reaction were removed by washing the particles with distilled water via suction filtration. After rinsing with anhydrous ethanol, the particles were dried in an air oven at 100 ^{o}C for 10 h and then calcined in flowing N_2 atmosphere at 1300 ^{o}C for 2h. Thickness of the shell layer was adjusted according to variation of Y^{3+}, Al^{3+}, Cr^{3+} concentrations/ YAG:Ce weight. Calculated value showing the core shell ratio according to their mass ratio using a spherical core shell model is defined as δ. $\delta = R_{core}/D_{shell}$, where R_{core} is the radius of the core, D_{shell} is the thickness of the shell. In present work, different samples with δ=1:1, 2:1 and 3:1 are prepared. Morphology of as prepared precursors and calcined powders were observed by confocal laser scanning microscope (Keyence VK-X100K) with laser wavelength of 408 nm. Phase identification was performed via X-ray diffraction (XRD) on a X-ray diffractometer (Cu K_{α}, Bruker model D8). Luminescent properties of as prepared phosphor are characterized by UV visible fluorescence spectrometer (Hitachi F-4600).

Formation mechanism of the core-shell structure:

YAG:Ce core is used as the starting material. During the precipitation process, YAG:Ce core provide heterogeneous nucleation matrix for the precipitant to form its nucleus. Gel like encapsulation structure is thereby prepared. After the calcination process, Y-Al-Cr precursor decompose and formed YAG:Cr layer around YAG:Ce core. The core-shell structure is thereby prepared. Detailed chemical and kinetic analysis for the YAG synthesis using urea precipitation method can be found in our former paper (Ref. 14, 20) paper published by D.D Guo (Ref. 21).

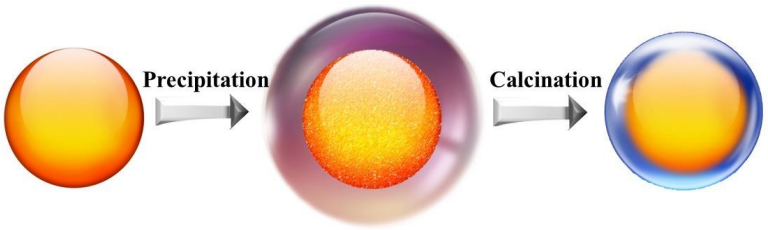

Figure S1. Formation mechanism of the core-shell structure