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Synthesis and scintillation characterization of nanocrystalline Lu2O3(Eu) powder for high-resolution X-ray imaging detectors

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In the last decade, digital X-ray imaging detectors using CCD arrays, CMOS and amorphous silicon flat panel (a-Si:H) in combination with various scintillation screens have been widely used for medical and industrial applications. The conventional scintillators such as thallium-doped cesium iodide (CsI:Tl) and terbium-doped gadolinium oxysulphide(Gd2O2S:Tb) and europium-doped gadolinium oxide(Gd2O3:Eu) were used for conversion of X-rays into visible light. However, new scintillators with excellent X-ray stopping power and high X-ray to light conversion efficiency are still researched and developed for low radiation dose and high spatial resolution applications. The scintillation screen based on nanocrystalline powders compared to commercially available scintillation screen with large particle size shows improved spatial resolution and higher detection efficiency.

In this work, Eu-doped Lu2O3 was synthesized via a homogeneous precipitation method using diethylamine (DEA) as a precipitant. First, the Lu(NO3)3·xH2O was dissolved in 50 ml of ethanol with continuous stirring to form a clear homogeneous solution. To the clear solution above, DEA was added drop-wise with vigorous continuous stirring. The solution immediately turned in to thick whitish slurry, which was further stirred in the same vigorous manner and precipitated. A small mound of DI water was added to the precipitate and allowed to stand for a few hours to ensure completed precipitation. After the reaction, the final products were systematically washed with DI water and ethanol by centrifugation. The powder obtained was subsequently dried at 60oC for 12 h and calcined from 700 to 1300 oC for different calcinations time in electrical furnace. Eu(NO3)3·6H2O was dissolved in the ethanol to form the homogeneous Eu-doped Lu2O3 powder. To the above solution, (100-x) mol% of calcined Lu2O3 powder was dispersed under sonication for 2 h. And then DEA was added to form a Eu-doped Lu2O3 in accordance with above procedures. By the reaction, round-shaped and homogenously dispersed Lu2O3(Eu) with 20˜30nm particle size was obtained. And then, X-ray diffraction (XRD) and scanning electron microscopy (SEM) were used in order to investigate the structural properties and microstructure of synthesized Lu2O3(Eu) powder. The scintillation properties, such as light emission spectrum, light intensity and decay time of the nanocrystalline Lu2O3(Eu) powder were measured by photo-luminescence (PL) and X-ray luminescence.

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