L.10: Synthesis of Ce:YAG powder and development of x-ray detection screen by sedimentation method

Cerium doped yttrium aluminum garnet (Ce:YAG) is a known phosphor material used for the detection of ionizing radiation and radiographic imaging. Cerium (Ce) doped (0.15 atm%) YAG nano-powder has been synthesized by co-precipitation method. Single phase formation was confirmed by powder x-ray diffraction (Figure L.10.1). The average particle size was found to be 200 nm (inset of Figure L.10.1).

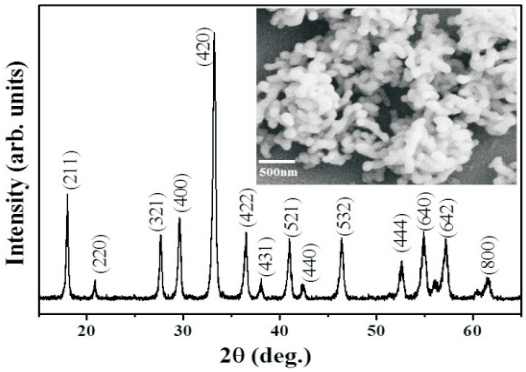


Fig.L.10.1:X-ray diffraction of synthesized Ce:YAG nano-powders. Inset shows SEM of same powder.

A phosphor screen of size 35x35 mm^2 was fabricated on glass substrate by sedimentation technique. For sedimentation purpose, 350 mg of Ce:YAG powder was dispersed in 100 ml water for 15 minutes. A chemically cleaned silica glass slide of 50x50 mm^2 was taken as substrate. The glass slide was placed at the bottom of a 500 ml beaker. The dispersed powder was poured slowly into the beaker and allowed to settle at room temperature for 12 hours. The residual water was removed carefully using peristatic pump and the screen was dried at 80 °C for 12 hours. The surface density of the screen was found to be 12 mg/cm^2. Figure L.10.2 shows the photograph of phosphor screen fabricated by sedimentation technique.

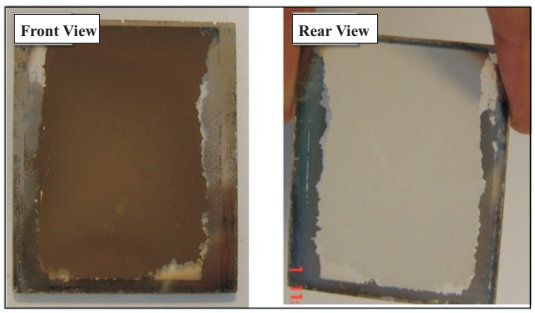
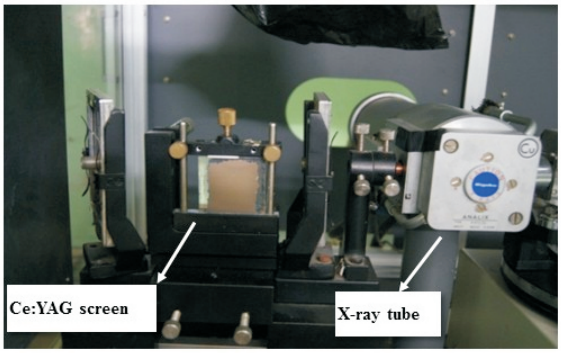
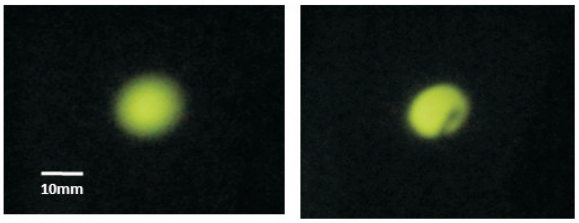


Fig. L.10.2: Photographs of phosphor screen prepared by sedimentation method.

X-ray scintillation for the phosphor screens was also tested. For this purpose, a Rigaku make x-ray generator (Geigerflex) was used. Figure L.10.3(a) shows the layout of experimental setup for x-ray exposure. The phosphor screen was fixed on an aluminium stand with arrangement of rotating the phosphor screen around its vertical axis. X-ray scintillation was observed in reflection mode by fixing the screen at 30° to its vertical axis in clockwise direction. The scintillation was recorded in digital camera for the x-ray tube operating at 40 kV and 30 mA. A manually as well as automatically controlled open-close shutter for x-ray was used to expose the screen.



(a)



(b) *(c)*

Fig. L.10.3: (a) Experimental setup for observation of scintillation in Ce:YAG screen, (b) observed scintillation of screen and, (c) image of metal pin on screen.

Figure L.10.3(b) shows a greenish colour scintillation for the phosphor screen. The green colour of the scintillation is due to 5d to 4f transitions in doped cerium ion. X-ray image of a metal pin was also clearly observed on the phosphor screen (Figure L.10.3(c)). Moreover, it is also observed that the scintillation dies off immediately after closing the shutter without any after glow. It is attributed to extremely low excited state life time (~66 ns) for 5d to 4f transition in Ce^{3+} ion as observed in synthesized Ce:YAG sample (*RRCAT Newsletter, 30 (1), L6, 2017*).

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