L.6: Development of transparent Cerium doped YAG ceramic

Cerium doped yttrium aluminum garnet (Ce:YAG) is a known scintillator used for the detection of ionizing radiation and medical radiographic imaging. Ceramic laboratory of Laser Materials Section, RRCAT, which is working on the development of transparent ceramics, has developed cerium (Ce) doped YAG transparent ceramic (Fig. L.6.1) by employing nano-powder technology and vacuum sintering technique.

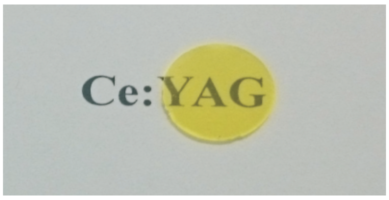

Fig.L.6.1: Photograph of transparent ceramics

Fig. L.6.2 shows the transmission spectra of 0.6 mm thick sample. It shows a transparency of ~75% (without Fresnel loss correction) in visible region. The transmission spectrum consists of two broad absorption bands centered near 340 and 460 nm in the UV/blue region.

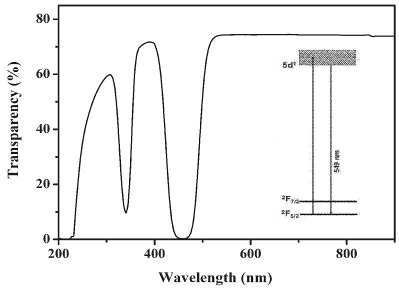

Fig. L.6.2: Transmission spectra of Ce:YAG ceramic

Emission spectra of ceramic sample is depicted in Fig. L.6.3.The emission occurs in greenish-yellow region with excited state life time of 66nsec.

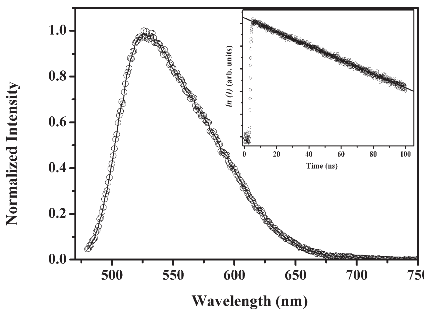

Fig.L.6.3:Emission spectra of Ce:YAG. Inset shows the decay curve.

For detection of high energy radiations, the emitted optical photons are captured by a photodiode which converts them into electric signal. The transparent Ce:YAG ceramic was tested for x-ray detection (indirect method). For this purpose, a large area Si-PIN diode was coupled to a 1.3mm thick ceramic sample. The ceramic sample was coated with silver (thickness ~100 nm) on one side, facing the x-ray radiation. The photodiode assembly used was also fabricated in RRCAT. A laboratory x-ray diffractometer with copper tube was used as a source of x-ray. Variation of photo-diode output with tube current was measured and it was observed that the response of photo-diode increases linearly with tube current(Fig. L.6.4).

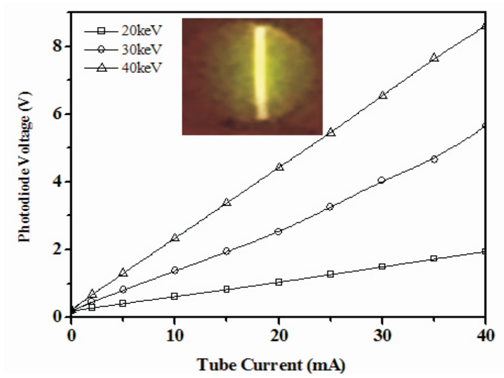

Fig. L.6.4: Response of photodiode for different x-raytube currents and voltages. Inset shows x-ray illuminated sample.

Using an optically polished sample of thickness 0.3 mm, the x-ray imaging was carried out on x-ray lithography beam line (BL-07) of Indus-2, RRCAT. The polished sample was fixed in an annular metallic disk with aperture ~10mm. The object to be imaged was hanged by a polypropylene based adhesive tape, about 10 cm away from the ceramic sample. The image produced on ceramic scintillator was captured using a CCD camera. Fig. L.6.5 shows the image of dead house-fly and black-ant produced on Ce:YAG ceramic sample.

Fig. L.6.5: Radiographic images of dead houseflies and black ant

A spatial resolution of 15-20micron could be achieved and efforts are going on to further improve the spatial resolution.

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