Conversion Efficiency of X-ray Scintillator and Phosphor Materials

S. Grantham, Z. Levine (RPI/NIST), E. Landree, T.B. Lucatorto, and T. Jach (NIST)

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Introduction: X-ray imaging incorporating x-ray to visible light conversion has advantages over direct x-ray imaging. Specifically, visible light conversion allows for a larger dynamic range and more compact instrumentation. With the goal of development of an x-ray microscope, the conversion efficiency of x-ray powder phosphor samples and x-ray scintillator crystals were measured.

Methods and Materials: The powder samples included $Y_3Al_5O_{12}$:Ce (YAG:Ce), Gd_2O_2S:Eu, Gd_2O_2S:Tb (P43) and the scintillators included $Bi_4Ge_3O_{12}$ (BGO), $CdWO_4$, Lu_2SiO_5:Ce (LSO), $Y_3Al_5O_{12}$:Ce (0.2%)(YAG), two proprietary crystals (STI-10G and -12.7R). Each sample was irradiated by monochromatic x-rays in a range of 2.2 to 5.0 keV. Measurements were made by incorporating a calibrated, low powered microscope to collect the visible light.

Results: Figure one shows the relative conversion efficiency (η) of the samples tested at four x-ray energies. The results show a variation in conversion efficiency with respect to materials and energy. This x-ray energy dependent variation of η in powder samples is due to x-ray penetration depth and visible scattering losses. Variations in η in the scintillator samples, however show variations, which correspond to x-ray absorption characteristics of the scintillator host materials and are not due to penetration depth limitations in the thick, low scatter scintillators.

Conclusions: The variations of scintillator response with x-ray energy can be predicted with modeling by incorporating the effects of surface recombination. Such effects have been noted for UV phosphors and qualitatively discussed for x-ray scintillators, but this work is the first to record these effects in this x-ray energy range and account for them with a quantitative model.

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References: E.L. Benitez et al., Appl. Phys. Lett. **70**, 3338 (1991); D. W. Aitken et al., IEEE Trans. on Nucl. Sci. **14**, 468(1967); V.V. Averkiev et al., Instr. and Exp. Tech. **33**, 799 (1990)

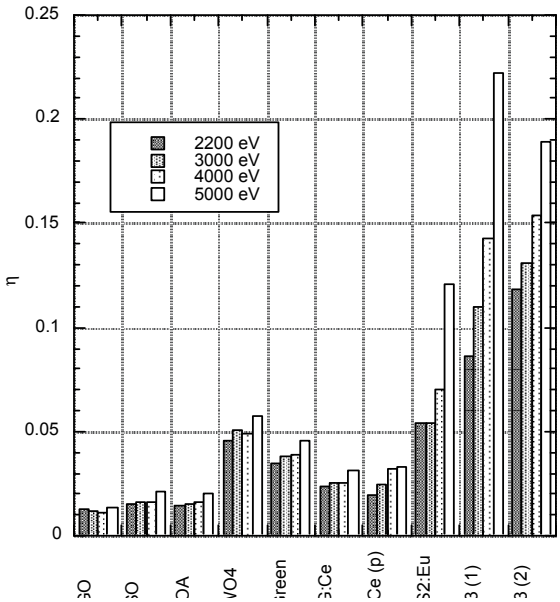

Figure 1. Relative conversion efficiency of x-ray scintillators and phosphor powder samples for x-ray energies between 2.2 and 5.0 keV .