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Light emission measurements of LFS-3 and GAGG:Ce single crystal samples under X-ray radiographic conditions

Abstract: Inorganic scintillating crystals are employed as radiation to light converters in most medical imaging modalities. This study presents a comparative investigation of the luminescence emission properties of LFS-3 (Zecotek Photonics Inc) and GAGG:Ce (Furukawa Co Ltd) single crystal scintillators under medical X-ray excitation. Both scintillating materials have dimensions of $10 \times 10 \times 10 \text{ mm}^3$ and $10 \times 10 \times 20 \text{ mm}^3$. The Absolute Luminescence Efficiency-AE (i.e., the light energy flux over exposure rate) and the so-called Effective Efficiency-EE (i.e., the light spectral compatibility with electronic optical sensors) were investigated under X-ray excitation in the radiographic energy range from 50 to 130 kVp. The AE and the EE parameters of the examined scintillators were found to increase with the X-ray tube voltage. The maximum AE value was found equal to 41.22 E.U (1 E.U equal to $\mu\text{W} \cdot \text{m}^{-2} / \text{mR} \cdot \text{s}$) for the GAGG:Ce scintillator at 130kVp X-ray tube voltage whereas for the same tube voltage the maximum AE for LFS-3 scintillator was equal to 22.29 E.U. This increased efficiency to the above X-ray voltage can be attributed to the high density of the materials, which enhances X-ray photon absorption, and their high light output. Both scintillators have higher efficiency than LSO:Ce (standard scintillator used in PET) which measured equal to 18 E.U. under the same conditions, thus LFS-3 and GAGG:Ce crystals might be considered for further research as suitable radiation detectors in medical imaging.

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