Thin LSO-based scintillating mixed-crystal grown by liquid phase epitaxy for high resolution X-ray imaging

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A digital X-ray detector for high resolution synchrotron microtomography and -radiography is commonly based on projecting a luminescence image magnified via microscope optics onto a CCD chip. The use of higher magnifying optics leads to a decrease of the corresponding focal depth. Therefore, thin scintillating single-crystals are required in order to convert the X-ray beam as attenuated by the sample into visible light while avoiding an image blurring (e.g. around 5 µm active layer for submicron resolution and 20 µm for resolutions around 2 µm) [1]. As a consequence the stopping power and with that the detector's efficiency decreases dramatically when working with higher resolutions. In recent years the number of imaging beamlines at third generation synchrotron light sources increased, leading to an ongoing demand and research for heavy scintillating materials available in thin active layers for microimaging. As one approach the CEA Léti together with the special detectors group of the European Synchrotron Radiation Facility (ESRF) used the liquid phase epitaxy technique to grow $Lu_3Al_5O_{12}$ (LuAG) crystals (doped with Eu or Tb) and $Gd_3Ga_5O_{12}$ (doped with Eu) as thin layers on top of non-doped substrates [2, 3]. Since the nineties LSO:Ce is known as a very fast and dense material highly suited for PET imaging [4] and was already suggested for the use in synchrotron imaging as well [1]. We present a continuation of the development by growing an LSO-based mixed-crystal ($Lu_{2-x}M_xSi_yGe_{1-y}O_5$ where M is a rare earth element and x and y are in the range between 0.001 and 0.05) on top of a non-doped substrate. The mixed-crystals allows an improvement of the stopping power compared to other materials like LuAG or GGG by a factor of 2. A digital X-ray detector using that crystal has a high potential not only for synchrotron imaging than also for applications within the non-destructive testing market in general.

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