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Compositional engineering of timing properties in Ce-doped multicomponent garnet-type scintillators

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Scintillators substantially faster than LYSO:Ce are currently in demand for medical imaging, particularly, for TOF-PETs. Ce-doped multicomponent garnets are prospective candidates due to the freedom for engineering of their scintillation properties by varying their composition without detrimental deterioration of the crystal structure and by appropriate codoping. We report on a study of the capability to substantially improve the timing properties of Ce-doped multicomponent garnets by engineering of gallium and gadolinium content in their lattice. Cathodoluminescence and photoluminescence spectroscopies with temporal resolution in picosecond domain were exploited, and the interpretations were supported by the simulations of excitation transfer. Lu0.75Gd2.25Ga2.5Al2.5O12:Ce codoped with Mg and Y3(Al1-xGax)5O12:Ce with different Al and Ga contents were studied. Our measurements and simulations show that the excitation transfer to the activator ion Ce3+ is delayed for tens or a few hundreds of nanoseconds due to the transfer of a part of the excitation through the Gd-sublattice. However, the delayed excitation transfer can be blocked by aliovalent codoping, in particular, by Mg. The PL intensity dependence on temperature fitted well with the Arrhenius formula, however, the extracted activation energies changed irregularly with Ga content. The experimental results were interpreted by the influence of a new channel for nonradiative recombination as the Ga content increases.

Field

Detectors and electronics

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