Abstract
Scintillation properties of new TlGdCl₃ single crystal is presented. Different Ce-doped (0, 0.5, 1 and 5 mol %) single crystals of TlGdCl₃ are grown by vertical Bridgman technique. All doped samples show typical Ce³⁺ emission under X-ray excitation between 350 nm and 500 nm. The emission peak positions slightly changed with the increase of Ce-concentration in the host matrix. Excellent light yield and good energy resolution is obtained under γ-ray excitation at room temperature. Three exponential decay components are obtained for all Ce-doped samples at room temperature. Decay components changes with Ce-concentrations i.e. get faster with higher Ce-concentration. Effective Z-number is found to be 66 and therefore X- and γ-ray detection will be detected efficiently with this scintillator. High light yield, high Z-number with moderate energy resolution and fast scintillation response suggest that this scintillator could be used in the medical imaging techniques. Further investigations are under way for the improvement of its scintillation properties with higher Ce-concentrations.

Crystal growth process

Photographic representation of the procedure followed for the growth of TlGdCl₃ crystals.

Experimental

Photographic representation of Bridgman furnace

Schematic representation and photographic view of Bridgman furnace

Grown TlGdCl₃ crystals

Experimental setup

Photographic view of the (a) X- and (b) γ-ray spectroscopy measurement apparatus.

Photographic representation of the X-ray induced luminescence spectra

X-ray induced luminescence spectra

Results

X-ray induced luminescence spectra

(a) Pure TlGdCl₃ crystal shows Gd³⁺ 4f-4f transition at 310 nm along with broad band emission in the range of 350-600 nm peaking at 402 nm.

(b) Doping TlGdCl₃ with Ce³⁺ ion, the peak at 310 nm disappear while similar emission bands between 375-550 nm having maximum emission at 405 are observed.

Pulse height spectra

Scintillation decay time

Decay time curves of (a) Pure and (b) Ce³⁺ doped TlGdCl₃ crystals.

Summary

- Pure TlGdCl₃ has low light yield and bad energy resolution, however doping Ce³⁺ ion in this material improves its scintillation performance.
- Light yield of 51000 ph/MeV with energy resolution of 6% (FWHM) was obtained for 5%Ce³⁺ doped TlGdCl₃ crystal under 662 keV γ-rays excitation. At the obtained light yield one can expect better energy resolution, which can be achieved by improvement in crystal quality.
- The relative contribution of fast decay component increased and other decay components become faster with increase in Ce³⁺ concentration.
- Further investigation on the optimization of Ce³⁺ doping, crystal growth conditions and raw materials purification is underway.