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In situ diagnostics and optimization of single crystal compound scintillator and semiconductor materials through energy-resolved neutron imaging

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The high cost, low yield and inconsistency of crystal growth are among the main obstacles for the introduction of new materials to widespread application in various detection devices. In-situ diagnostics during crystal growth can be very helpful for the optimization of the growth process of a specific material. Neutrons appear to be unique probes providing information on the distribution of elements via nuclear resonance absorption, location of liquid/solid interfaces via different contrasts between elements and some information on the crystallographic structure (such as mosaicity) via Bragg scattering. Recent development of in-situ neutron imaging technique conducted at pulsed neutron sources demonstrate the possibility to visualize in real time (in crystal growth terms) the location of the liquid/solid interface, uniformity of crystal orientation and lattice parameter as well as elemental distribution. In this paper we demonstrate how crystal growth parameters can be optimized in-situ allowing substantial reduction of time required for the optimization of growth conditions. We performed in-situ imaging during crystal growth of several gamma scintillator materials: BaBrCl:Eu, Cs2LiLaBr6:Ce, CsI:Eu and others. These crystals were grown by the Bridgman process performed within a dedicated furnace, designed specifically for neutron imaging. Our experiments demonstrate the unique capabilities of energy-resolved neutron imaging to measure various characteristics of crystal growth process with sub-mm spatial resolution and with a ~minute timing resolution, sufficient for slow crystal growth processes.

Speakers Gender

Male

Level of Expertise

Experienced Research

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