NSSC 7

NUCLEAR SCIENCE and SECURITY CONSORTIUM

Webinar

New Organic Scintillators for Wide-Energy Neutron Detection

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Abstract

Efficient detection of special nuclear materials (SNM) requires instruments which can sensitively detect and characterize uranium and plutonium isotopes in a wide range of energies, having at the same time the extremely important ability to discriminate among different types of radiation. For many decades, neutron detection technology has been based on ^{3}He proportional counters that are sensitive primarily to thermal neutrons. The most common methods for direct detection of fast neutrons have been based on liquid organic scintillators with PSD properties. The recent shortage of ^{3}He and handling issues with liquid scintillators stimulated a search for efficient solid-state PSD materials. A broad survey of organic single crystals conducted in the present work provided large number of new materials, which became available for studies of PSD phenomena. New organic crystals [1] with excellent PSD have been developed for fast neutron detection. Knowledge obtained in the studies with single crystals led to development of the first plastic scintillators with efficient fast neutron/gamma PSD [2]. More advantages have been introduced by the next generation of plastics doped with neutron capture agents. Loading with ^{10}B resulted in a new type of organic scintillators useful for combined detection of both thermal and fast neutrons discriminated from gamma radiation background. The most recent development produced the first ever ^{6}Li-loaded plastic scintillators that, in addition to simultaneous detection of fast and thermal neutrons, offer a unique “triple” PSD for signal separation between fast neutrons, thermal neutrons, and gamma-rays. Among new materials developed for commercial production are large-scale (>10 cm) stilbene single crystals grown by the inexpensive solution growth technique, and different types of new PSD plastics which, due to the deployment advantages and ease of fabrication, create a good basis for the replacement of liquid scintillators and widespread use as future large-volume and low-cost neutron detectors.

1. N. Zaitseva, et al, IEEE Trans. Nucl. Sci., 58, (2011) 3411-3420.
2. N. Zaitseva, et al, Nuclear Inst. and Methods in Physics Research, A (2012) pp. 88-93

About Dr. Natalia Zaitseva

In 1993, Dr. Zaitseva joined Lawrence Livermore National Laboratory to lead scientific development of rapid growth technology for large-scale (>50 cm) KDP and DKDP crystals for the National Ignition Facility (NIF). Dr. Zaitseva is currently the PI for projects on development of new classes of organic scintillator materials for radiation detection funded by DHS/DNDO,and DOE NA-22 and DTRA offices. She and her team conducted extensive survey and studies of organic materials capable of neutron/gamma Pulse Shape Discrimination (PSD). The results led to discovery of new single crystal organic scintillators and first plastic scintillators with efficient PSD, transferred to industry for commercial production. Dr. Zaitseva received worldwide recognition for her work in studies and development of new materials. She is a recipient of the International Robert Laudise Award in crystal growth (2010), two 100 R&D awards for the development of Rapid growth technology for production of large-scale crystals (1994) and first PSD plastic scintillators for neutron detection (2012), numerous LLNL Directorate awards (1994-2013), and DNS/DNDO award for development of new crystals for radiation detection. She is an author of more than 80 publications and 9 patents.