2012 R&D 100 50th ANNIVERSARY

A SOLID SOLUTION FOR NEUTRON AND GAMMA-RAY DISCRIMINATION

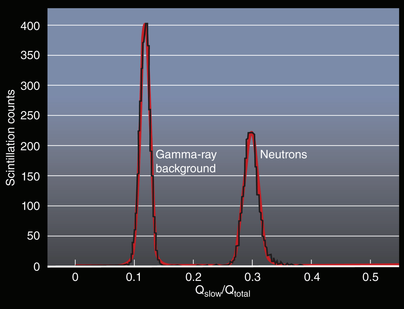
Lawrence Livermore scientists joined forces with collaborators from Eljen Technology in Texas to develop an enhanced plastic scintillator material. These plastic scintillators for neutron and gamma-ray detection offer efficient pulse-shape discrimination and can distinguish neutrons from gamma rays with equal or better resolution than is available with standard commercial liquid scintillators. The breakthrough material consists of a very high concentration of scintillating dye suspended in a polyvinyltoluene polymer matrix. While plastic scintillators have been around since the 1950s, using such a high concentration of dye had not been considered to be a viable pathway.

Scintillating Materials Detect Radiation

For years, plastic scintillators have been used in gamma-ray detectors at transportation portals and at international crossing points. While conventional plastic scintillators can detect both gamma rays and neutrons, they have not been capable of distinguishing one from the other. Organic crystals currently serve as one of the best types of neutron detectors, but the crystals can be difficult to grow and obtain in large volumes. Liquid scintillators present several hazards that hinder their use. Conversely, plastic scintillators pose none of the hazards or difficulties associated with those scintillator options. Moreover, the ease at which plastic scintillators can be shaped and fabricated makes them an extremely useful material for gamma-discrimination applications.

Overcoming the Skeptics

The thought that plastic scintillators could be created to efficiently discriminate neutrons from gamma rays came about, in part, from growing crystals with mixtures of the scintillating chemicals diphenylacetylene (DPAC) and stilbene. The researchers mixed DPAC with stilbene and at 18 percent, they could distinguish neutrons from gamma rays. Once they hit 40 percent, they had the full function. Reversing more than five decades of prevailing opinion by skeptics who said it could not be done, this diverse team of researchers has demonstrated that their enhanced plastic scintillator material can efficiently differentiate neutrons from the gamma rays emanating from radioactive substances. Accurately detecting illicit radioactive material moving through customs, border crossings, and pedestrian and transportation inspection portals is a critical national security objective for the U.S.



In this experimental test with a californium-252 fission source, the measured scintillation pulses from the neutrons are clearly distinguishable from the background signal. (Q_{slow}/Q_{total} is the ratio of delayed light to total light.)

Livermore physicist Natalia Zaitseva leads a research team that has developed the first plastic material capable of efficiently distinguishing neutrons from gamma rays.

Livermore development team for plastic scintillators: (standing from left) Paul Martinez, Andrew Glenn, Sebastien Hamel, Steve Payne, and Keith Lewis; (sitting from left) Nerine Cherepy, Natalia Zaitseva, Iwona Pawelczak, Michelle Faust, and Leslie Carman. (Not shown: Ben Rupert; Charles Hurlbut, Loretta Hernandez, and Matt Jackson of Eljen Technology.)

Lawrence Livermore National Laboratory

For more information: www.llnl.gov

This work was supported by NA-22 of the Department of Energy

Prepared by LLNL under Contract DE-AC52-07NA27344. LLNL-POST-584313