PLASTIC DETECTORS IN NUCLEAR PHYSICS

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A brief survey of plastic detectors (scintillators), polarizable plastic detectors for various radiation measurement applications, for neutrons, alpha and beta detections, radiation resistance of plastic detectors is presented here. The utility of plastic scintillators for practical applications such as gamma radiation monitoring, real-time radioisotope detection and screening is evaluated in laboratory and field measurements. Small- and large-size plastic detectors are evaluated for static and dynamic gamma-ray detection sensitivity of selected radiation sources.

Inorganic crystalline scintillators such as sodium iodide (NaI), bismuth germanate, $Bi_4Ge_3O_{12}$ (BGO) and cesium iodide (CsI) are conventionally used in gamma-ray spectroscopy for their linear response, enormous light output (a factor of 4 better than a plastic scintillator), relatively higher absolute scintillation efficiency (~12%) and good energy resolution. Plastic scintillators have so far been ignored in field applications for gamma-ray measurements, even though they have some practical advantages over inorganic scintillators in terms of being less dense, less expensive, less temperature sensitive, rugged and are manufactured in large machinable volume. Plastic scintillators enjoy the unique advantage over NaI(Tl) that they have usable neutron response. The neutron detection efficiency (~8-12%) is dependent on the energy, threshold, thickness and volume of the plastic scintillator used. Neutron pulses are slower than gamma scintillator pulses and are easily separable in liquid scintillators.

The ideal scintillator should possess the following properties:

· It should convert the kinetic energy of charged particles into detectable light with high scintillation efficiency;

· The conversion should be linear; the light yield should be proportional to deposited energy over as wide a range as possible;

· The medium should be transparent to the wavelength of its own emission for good light collection;

· The decay time of the induced luminescence should be short so that fast signal pulses can be generated;

· The material should be of good optical quality and subject to manufacture in sizes large enough to be of interest as a practical detector;

· Its index of refraction should be near that of glass (~ 1.5) to permit efficient coupling of the scintillation light to a photomultiplier tube.

Plastic detectors are used in multiple radiation detection and measurement systems under diverse experimental conditions, because of their light weight, large area, considerable light output, radiation hardness and polarizability. For safeguard applications, plastic detectors can be used in portal and vehicle monitors. Even though plastic scintillators have significant non-linearity in their light output (so no spectral information can be obtained from gamma radiation) for non-spectroscopic gamma detection work, plastic detectors are better than inorganic detectors.