Scintillation Materials, Detectors and Electronics

Scintillation Material Data Sheet

PLASTIC SCINTILLATORS

Plastic scintillators are solid solutions of luminofores (luminescent additives) in a transparent polymer (polystyrene (PST).

Many characteristics of plastic scintillation materials (light output, transparency to own emission, decay time, radiation resistance) can be varied by changing their composition.

Plastic scintillators give a fast signal (a few ns) and a high light output. Plastics can be shaped very easily and machined to the forms desired in assemblies (cylinders, rods, flat sheets, fibers, microspheres and thin films) and are relatively inexpensive, that is why they are among the most widely used scintillators. They are generally quite resistant but can be scratched and are easily attacked by organic solvents.

Polystyrene-based scintillators

Scintillators with a polystyrene matrix are used to detect α-, β-, γ- radiation, x-rays and fast neutrons. Plastic scintillators are prepared by bulk polymerization in aluminium (size up to 3.5 m) or glass mold cast and by injection molding technique.

Polystyrene-based scintillators are used for the detection of ionizing radiation in high energy physics. Their application is determined by a number of valuable properties – low decay time (2-3 ns), high resistance to radiation (to 10 Mrad), temperature (from -40 to +60°C) and moisture, resistance to mechanical stress, vacuum resistance, and also weak dependence of light output from temperature in the range from 20°C until the softening temperature.

Large-sized plastic scintillators are used for the registration of elementary particle of high energy in space research, and also to determine low activity, such as gamma activity of a living organism.

Plastic scintillators are widely used for gamma-radiation and unsuitable for gamma-ray spectrometry. This is due to their elemental composition – the presence of only light elements (C, H).

Cylindrical plastic scintillators (Ø until 300 mm and *h* 500 mm) are used for gamma-radiation of medium energies, in particular for devices of geological exploration. Small volume detectors with high light output and small decay time are used for the high radiation γ-flux.

Properties of standard polystyrene scintillation material

Density, g/cm^3	1.06
Refractive index	1.6
Absorption coefficient, cm^{-1}	0.002 – 0.005
Softening temperature, K	355 – 360
Hygroscopicity	no
Light output, % of anthracene	56
Rise time, ns	0.9
Decay time, ns	2-3
Number of H Atoms per cm^3, 10^{22}	4.91
Number of C Atoms per cm^3, 10^{22}	4.91
Ratio H:C Atoms	1.0
Number of Electrons per cm^3, 10^{23}	3.44
Wavelength of maximum emission, nm	418
Tensile stress at yield, MPa	41
Tensile strength, MPa	41
Tensile modules, MPa	3900
Bending strength, MPa	61
Bending modules, Mpa	3900
Compressive strength, MPa	51
Compressive modules, MPa	1500

Application of the polystyrene-based scintillators

Application area	***Detecting radiation***	***Type of detector***	***Typical dimensions, mm***
Space research	Elementary particle of high energies	Large-size detectors Detectors of high volume and different configuration Scinticamera	1200x1200x20; 1200x1200x100; Ø 1000, *h* = 500 rods *l* = 1400; *d* = 5, 10, 20, 30
Geological research Definition of radioactivity in the organism	Gamma-radiation of low and medium activity	Well-type cylindrical; cylinder	Ø 300-400, *h* = 500; ØB = 1200 ØBH = 800 *h* = 300 Ø 30-40 *h* = 30-40