Response of CsI:Pb scintillator crystal to neutron radiation

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The helium-3 world crisis requires a development of new methods of neutron detection to replace commonly used ^{3}He proportional counters. In the past decades, great effort was made to developed efficient and fast scintillators to detect radiation.[1] These detectors should, then, be carefully characterized both experimentally and by means of advanced simulation code. Ideally, the detector should have the capability to separate neutron and gamma induced events either by amplitude or through pulse shape differences. As neutron sources also generate gamma radiation, which can interfere with the measurement, it is necessary that the detector be able to discriminate the presence of such radiation. Considerable progress has been achieved to develop new inorganic scintillators, in particular increasing the light output and decreasing the decay time by optimized doping.
Crystals may be found to suit neutron detection. In this report, we will present the results of the study of lead doped cesium iodide crystals (CsI:Pb) grown in our laboratory, using the vertical Bridgman technique. The concentration of the lead doping element (Pb) was studied in the range $5x10^{-4}$M to 10^{-2}M. The crystals grown were subjected to annealing (heat treatment). In this procedure, vacuum of 10^{-6} mbar and continuous temperature of 350°C, for 24 hours, were employed. In response to neutron radiation, an AmBe source with energy range of 1 MeV to 12 MeV was used. The activity of the AmBe source was 1Ci Am. The fluency was 2.6 x 10^{6} neutrons/second. The operating voltage of the photomultiplier tube was 1300 V; the accumulation time in the counting process was 600 s and 1800 s. The scintillator crystals used were cut with dimensions of 20 mm diameter and 10 mm height. The Monte Carlo method was used to determine the neutron flux arriving in the detector and the calculated values were obtained by means of MCNP code.

References

[1] G. F. Knoll, Radiation Detection, 4th edition,2010.