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Development of InP solid state detector and liquid scintillator containing indium complexes for a measurement of pp/^{7}Be solar neutrinos

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Abstract

Am semi-insulating indium phosphide detector has been developed for IPNOS experiment and it could detect both γ's and the scintillation light. We have also developed an organic liquid scintillator which contains indium and zirconium complexes, and found the gamma-ray-induced luminescence of 8-quinolinol metal complexes.

Keywords: solar neutrinos, solid state detector, liquid scintillator, double beta decay

1. Performance of InP detector

For observation of pp/^{7}Be solar neutrinos, the following reaction $^{115}\mathrm{In} + \nu_e \rightarrow ^{115}\mathrm{Sn}^* + e^-$ could have advantages that (1) large cross section, (2) low energy threshold and (3) triple coincidence (e+γ_1+γ_2) to extract signal [1]. We have developed semi-insulating InP detector for IPNOS experiment. Two γ's might escape from the InP detector, so that the liquid scintillator such as liquid xenon should be used for both detecting γ's and coolant of InP detector.

In order to detect scintillation light, we have developed InP detector (6mm $\times$ 6mm $\times$ 20μm) with thin electrodes which consist of Cr/Au (10/10nm). The scintillation light was used for CsI which irradiated by ^{241}Am α source. This detector could detect both γ's and scintillation light. The transparency of Au/Cr electrodes were estimated by $0.57 \times 0.37 = 0.21$, and observed charge were 0.5 $\sim$ 2.0fC. Therefore, the photon conversion efficiency was obtained by 0.3. In case of liquid xenon, the transparency of Au/Cr electrode will be $0.43 \times 0.39 = 0.17$, and assuming same conversion efficiency and photon coverage to be 0.8, the expected scintillation yield will be $\sim$ 3keV equivalent. This is not enough for the detection, so that we have to modify shape of electrode. Assuming 50% for naked area of InP surface, the transparency will be recovered by 0.58, then the expected yield should be $\sim$ 10keV equivalent.

2. Liquid scintillator containing metal complexes

An organic liquid scintillator containing indium and zirconium complex were studied for low energy solar neutrinos and double beta decay, respectively. We have chosen tris (8-quinolinolato) complex which has photo luminescence. Benzonitrile was also chosen as a solvent because of good solubility for the complexes (2 wt%) and good light yield. The photo-luminescence emission spectra of InQ_3 and ZrQ_4 in benzonitrile was measured. The emission maxima for InQ_3 and ZrQ_4 were found at 559nm and 548n, respectively. We prepared 50mg of complex in benzonitrile solutions (20 mL). Two secondary scintillators, 100 mg of PPO and 10 mg of POPOP, are also dissolved as a wavelength shifter. The energy spectra of electrons emitted by Compton scattering of incident gamma-ray using ^{60}Co was obtained. The quantum yield was obtained by 15.6% and 11.5%, respectively. We will modify 8-quinolinolate ligand to add substituent groups in order to both increase quantum yield and shorten wavelength of luminescence.

References

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