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ANAIS - PROCEEDINGS

DEVELOPMENT OF PLASTIC SCINTILLATORS FOR USE IN THE FIELD OF RADIOPROTECTION AND ENVIRONMENTAL MONITORING

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Abstract

Development of plastic scintillator detector based on locally available knou how, for various applications i.e. radiological protection - whole body counting , continuous monitoring of air and measurement of low level alpha and beta radioactivity in environmental samples is described. Results of method of preparation of the plastic scintillator using styrene monomer and PPO (scintillator), POPOP (wave lenght shifter) are described. For measurement of gamma radiation point sources of ^{60}Co, ^{137}Cs and ^{125}I were used and detected with plastic scintillator detectors prepared with various concentrations (% by weight) of PPO. The data of relative pulse heights are presented. For measurement of alpha and beta radioactivity in environmental samples, thin discs of plastic detector were machined and polished. Other aspects i.e. range of α, β particles , thickness of light guide, reflector, geometry, distance between sample and detector and detector to photomultiphier distance are being analyzed from theorical considerations. Necessary experimental data are being generated to optimize various parameters of synthesis fo styrene polymer and the above mentioned detector parameters.

INTRODUCTION

Plastic scintillator detectors are used in radioactivity measurement because, they can be manufactured in large volumes at low cost ; offer great transparency to the luminescent radiation and can be machined/polished without difficulty. [1]. The plastic scintillator detector is specially useful for the whole body counting, low level environmental measurements (α,β activity and low γ energies). Although they yield only approximately a quarter of the light output of conventional NaI(Tl) crystal, on the other hand, they aren't hygroscopic and can be assembled with thiner protective shield.

Its preparation bas been described since 1950 [1], however, paradoxically its apllication doesn't seen to be widely exploited.

In this work, some preliminary results of preparation of a plastic scintillatior detector for, routine whole body counting and measurement of low level α , β radioactity in environmental samples are presented.

EXPERIMENTAL

The materials used were as following i) styrene monomer (Cia Brasileira de Estireno) with less than 0,5% of impurity with 15 to 20 ppm T.B.C. inhibitor ii) PPO (Sigma) and iii) POPOP (Amersham Searle).

The plastic was prepared as folowings: 0,1% or 1% or 5% by weight of PPO and 0,05% by weight of POPOP were added to styrene in a glass vial. To allow for thermal expansion of the solute during the polimerisation, the volume of this vial was made about 15% grather than that of the solution to be polymerized. By means of a mechanical pump air is exhausted from the vial. Alternate freezing and thawing of the monomer during this pumping process may be used to facilite removal of dissolved air. The vial was then sealed under vacuum and placed in a thermostatically controlled oil bath at 110ºC. When the sample had attained the temperature of the bath, the vial was be removed momentarily and shaken vigorously to ensure complete solution and mixing of the fluor. The styrene-solution was polymerized at 110ºC for a period of 3-4 days. No catalyst was used to aid polymerization.

At the end of polymerization period, the vial was removed from the oil bath, and cooled. After cooling the scintillator was removed from glass vial by breaking and machined in the desired form. The machined product was given a polished finish before using as a ordinary detector.

Three point sources (^{60}Co, ^{137}Cs, ^{125}I) were used to determine pulse height using a plastic scintillator detector with varying (0,1%, 1,0%, 5,0% by wt) of PPO.

Pulse height of three different PPO concentration was compared using a conventional liquid scintillation system (LSS) Beckman model LS-150 assembled with two RCA bialkali 12-Stage head-on type of photomultiplier tubes. In addition a multi-channel pulse height analyser (TMC model 401) was coupled to LSS device via "AMP OUT" signal from the amplifier PC-board localized at rear of the LSS device.

The results are presented in figures 1, 2 and 3. In the fig 4 are summarized the relative pulse height.

The range of concentration of PPO studied indicate an optimun pulse height between 0,5 to 2,0% by weight, wich is in agreement with results of other investigators [2].

For measurement of activity, the recommended disc thickness 5μm to 1mm and for β activity is 0,1 to 1mm. Work of preparations (machining/polishing) of discs of various thicknesses was carried out to be used on with the photomultipler which forms part of a ZnS(Ag) scintillation counter. Lucite light guides of diferent thickinesses were also prepared. In addition conical light reflector is also being elaborated. The variation of pulse height in function of sample thickness mg/cm^2, detector thickness, thickness of light guide, distance between sample and detector, and detector to photomultiphier distance is being studied to assemble a detector for comparison with similar detectors described in the literature.

BIBLIOGRAPHY

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2 - BECK, W.L. & SWANK, R.K. - Preparation and performance of efficient plastic scintillators. Nucleonics: 11: 48-53, 1953.

FIGURES

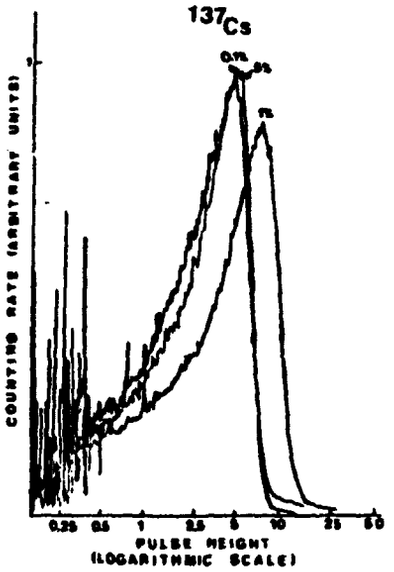

Figure 1

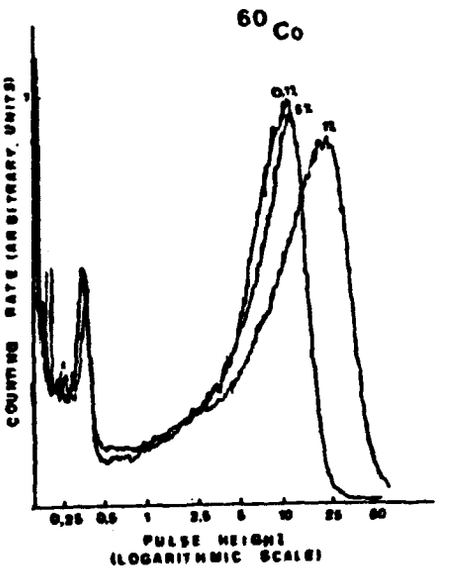

Figure 2

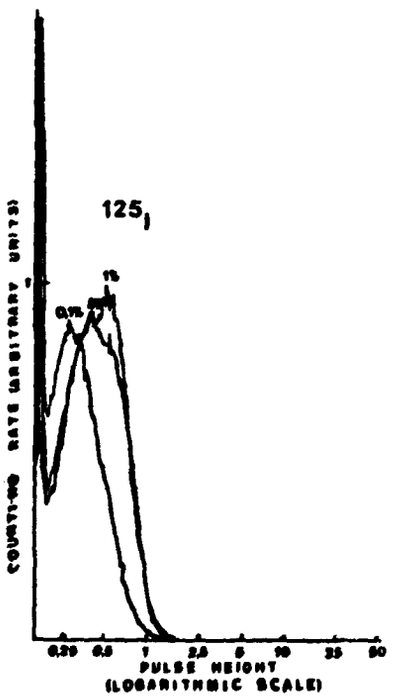

Figure 3

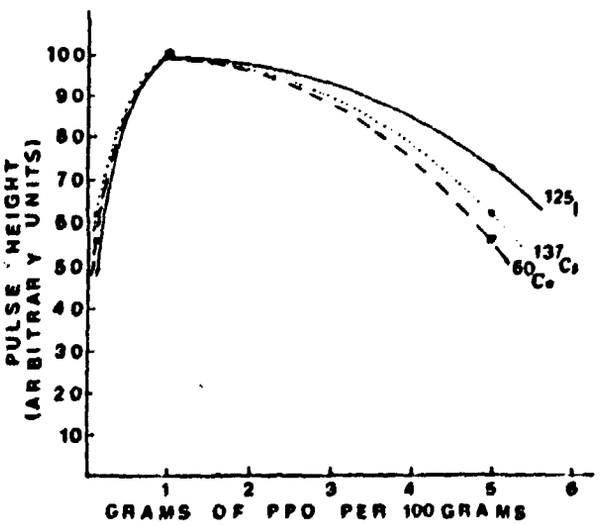

Figure 4