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Scintillation Counting of Aqueous Solutions[1]

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INTRODUCTION

Liquid scintillation counting of low energy beta emitters has become accepted as a valuable technique. It requires suitable, non-quenching solvents, which are compatible at counting temperatures with both the material under analysis and the phosphor. Unfortunately, such solutions cannot be prepared with many compounds of biochemical interest (*e.g.:* proteins). Suspension of insoluble materials in phosphor solution gels has not proven to be generally useful. Of necessity, a common approach is the formation of reaction products which are soluble (*e.g.:* with organic amines), but this renders the substance unsuitable for further use and/or study. These "stubborn" materials are almost always water soluble.

Steinberg (1, 2) suggested using solid phase phosphors, as particles or filaments, for counting aqueous solutions. He achieved reasonable efficiency (29% for C^{14}) using hand packed plastic phosphor filaments. The described technique was laborious, and not applicable to routine counting of multiple samples. The method did feature quantitative recovery of the unchanged, uncontaminated radio-active substance.

We modified the procedure to retain its desirable features, and also permit rapid, inexpensive, and reproducable routine counting. Water and alcohol insoluble plastic filaments (containing phosphor) are permanently fabricated into small, uniform "dumb-bells" (Fig. 1). Solutions are introduced into the interstices by capillary action, and the unit supported in an empty vial for counting. The sample is then recovered by soaking.

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[1]Contribution from the Department of Biochemistry, Albany Medical College, Albany, N. Y.

MATERIALS

Scintillation "B" Filaments, 0.5 mm diameter and 25 mm long;[1] glass tubing, 4.5 mm I.D. and 1 mm wall thickness; scintillation counting vial, 5 dram;[2] plastic vial, ⅜ inch diameter and 1¼ inches long.[3]

PROCEDURE

Cut glass tubing into approximately one-half inch lengths. Pack the plastic filaments (approximately 60) tightly into the tubing, and align the ends by tapping vertically against a flat surface. Slide the glass piece to allow only 1 mm protrusion of the filaments, which are then fused by holding near an open flame. Slide the glass tubing to 1 mm from the opposite end of the plastic bundle, and repeat the fusion. The tubing is removed by gently crushing the glass with a pair of pliers. The result is uniform, "dumb-bell" shaped units.

EXPERIMENTAL

A standard solution was prepared, containing 50,000 disintegrations per minute per milliliter of $Na_2C^{14}O_3$. The aqueous solution was introduced into the unit by a micro-syringe, whose #25 needle was inserted into the center of the "dumb-bell". (Alternatively, we have added surface active agents to either the sample or the filaments, and then pipetted the solution onto the "dumb-bell's"

[1]Pilot Chemicals, Inc., Watertown, Mass.
[2]Packard Instrument Company, Inc., LaGrange, Ill.
[3]Celluplastic Corporation, Fitchburg, Mass.

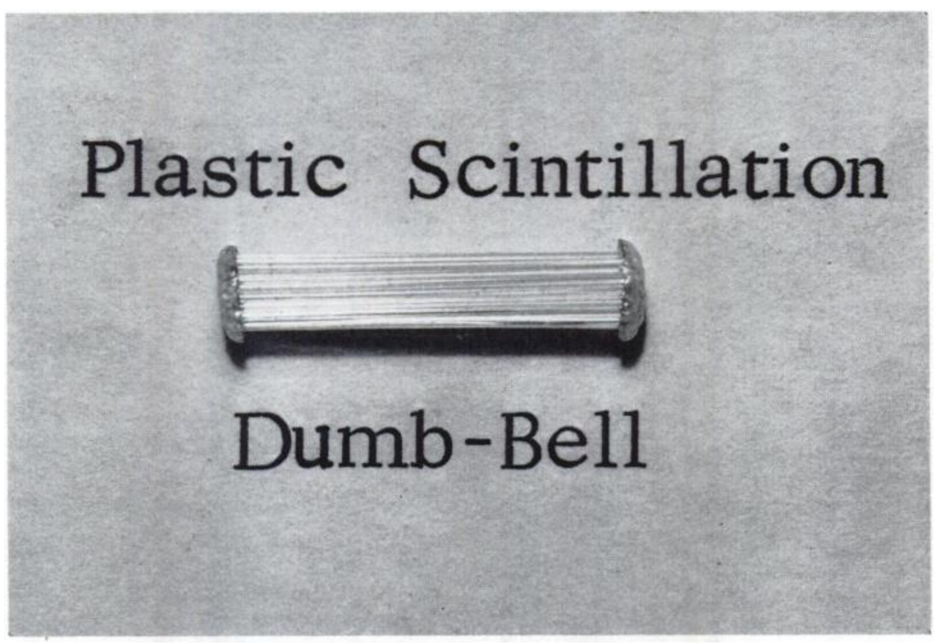

Fig. 1

outer surface.) The sample distributes itself within the interstices by capillary action.

The unit then was placed within a small plastic vial, which in turn was stood within a standard counting vial. This oriented the filaments perpendicularly to the photo-tubes. Counting was performed in the usual manner.[4]

RESULTS

Sample No.	*Microliters*	*Disintegrations/minute*	*Counts/minute*	*Efficiency*
1	0	0	7	
2	50	2,500	716	28%
3	50	2,500	736	29%
4	50	2,500	709	28%
5	25	1,250	362	28%

DISCUSSION

The simple unit described will allow efficient (28% for C^{14}) counting of aqueous solutions, without destruction of the sample. Many units can be made easily, and used interchangeably. Conceivably, mass production could provide disposable units.

Each interstitial space has a cross-sectional area 5 per cent that of a single filament, and the interstitial volume is 10 per cent that of the plastic bundle. Even greater efficiency might be obtained by the use of finer filaments. The unit described has a capacity of 50 microliters, and efficiency is unrelated to sample volume, up to and including this maximum. After counting, the sample is recovered by prolonged soaking.

An increase in efficiency, up to 33 per cent, was noted when the filaments (acting as "light pipes") were oriented to face into the photo-tubes. This phenomenon could be exploited when using manual sample changers. However, there is too much variation in orientation (with variable increase in efficiency) with the use of automatic changers

Simple and rapid trapping and counting of plasma $C^{14}O_2$ has been accomplished utilizing this technique. Alcoholic solutions of NaOH were used to deposit the alkali within the interstices. The "dumb-bell" was placed within its vials, and attached to a device for $C^{14}O_2$ liberation and trapping, previously described. (3) The vial was then capped and counted.

[4]Packard "Tricarb" liquid scintillation counter, made available through the cooperation of Mr. Irving Sax, head of Radiological Sciences Group, New York State Department of Health, Division of Laboratories and Research.

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3. MOSS, G.: *Int. J. appl. Rad. Isotopes* **11**:47, 1961.