Improvements in the Making of Special Photographic Emulsions for Nuclear Physics

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In 1945 (1) the author prepared concentrated, very fine-grained emulsions such as emulsion formula 2 (*2*), in which it has proved possible to record, with good detail and discrimination, the tracks of fission fragments (*3*), alpha rays, protons, and even of slow electrons (*1, 2*). Experience has shown us that the properties of these emulsions are not easily reproduced (*4*). The critical factors have been found to be: the mechanical and stoichiometric conditions during the mixing operation; the temperature of the wash water, which should be preferably below 5° C; and the gelatine used.

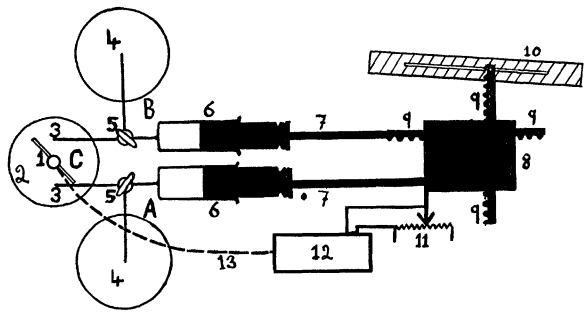

FIG. 1. Schematic view from above of emulsion-making machine. Sliding parts are shown in heavy black. Part 1 represents a stirrer; 2, a beaker containing solution C; 3, pouring tips; 4, tanks of solutions A and B; 5, three-way stopcocks; 6, 100-ml syringes; 7, pushing rods; 8, sliding carriage (bench carrying 8 and motor moving it are not shown); 9, right angle racks sliding inside 8 and linked through pinion (not shown); 10, sheet with slot guiding the movement of racks 9; 11, potentiometer regulating speed of motor 12; 13, flexible shaft from motor 12 to stirrer 1.

To control mechanical and stoichiometric factors, a machine has been designed and built that is illustrated schematically in Fig 1. To the stirred C solution, solutions A (600 g $AgNO_3$/1000 ml solution) and B (420 g KBr/1000 ml of solution) are added simultaneously, through the action of syringes, pushing rods, and carriage, moved by a motor sliding along a bench. Volumes of solutions A and B are kept constantly equivalent or nearly so, B being in slight excess. The double rack mechanism with its guiding slot introduces an adjustable difference between the movements of the pistons of syringes containing A and B, and thus allows one to cope with a difference of diameter between pistons, and with inaccuracies of concentrations of A and B. Also, through the peculiar shape of the slot chosen, it is possible to vary the excess (B-A) at will during mixing. The system also fills up syringes when they are empty. Here are numerical data for solution C: 15 g gelatine, 167 ml water, and 83 ml ethyl alcohol; use at 40–50° C. First add 1.3 ml of B. Then deliver at equivalent rates 100 ml of A and B, taking 2–3 min. Increase the stirring rate from 240 to 550 rpm. Chill and set at 0–2° C (1 hr). Break the jelly in small pieces and wash at 0–2° C (1 hr). Collect, melt, coat, dry, and sensitize 1 min in 6% triethanolamine before use.

In this method, the mixing phase is highly critical but there is no high temperature treatment. In preparing ordinary emulsions, mixing may be less critical but the heat treatment is a delicate phase.

This machine has been used with uniformly good results. A prototype of it, using 30% syringe sizes and quantities in mixing, has been in operation for nearly a year with consistently good results. Under its standardized conditions, 13 gelatine samples have been tried, and all gave good tracks of alpha rays and protons, and at least a peculiar granular appearance with radium D electrons. The best electron tracks (40–60 kv) resulted from gelatines labeled "fast negative," that is, from gelatines recommended for obtaining the greatest light sensitivity.

This gives us further reason to believe that similar active centers are essential both for light and for ionizing particles. Still unexplained is the lack of connection noted between light and particle sensitivity for various emulsions, which probably depends on the disposition of active centers on the AgBr grains.

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References

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Sensitivity of Gamma-Ray Counters[1]

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Radioisotopes can be investigated in many cases only by detection of their gamma radiation. Measurements of the distribution and the amount of an isotope used for tracer studies or for therapeutic purposes are often based on counting the gamma rays emitted in a certain direction (*3*). The sizes of source and gamma-ray counter, and the distance between them, determine the fraction of the total gamma radiation which is incident on the detector. The actual number of registered counts is again only a fraction of the incident gamma rays, depending on the sensitivity of the counter. It is known that even counters made from high atomic material detect only 0.7–2% of the gamma rays with energies between 0.5–3.0 Mev when the gamma radiation penetrates the counter walls perpendicularly (*2*). This low counter sensitivity is a serious limitation for many investigations. Different methods which result in a higher counting sensitivity will be outlined here.

Somewhat higher sensitivities can be obtained by using

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