LOADING OF EMULSIONS WITH DIAMONDS AND POLYSTYRENE FOR EXPERIMENTS WITH STOPPING K-PARTICLES

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INTRODUCTION

A considerable amount of work has been devoted to the problem of incorporating or loading compounds and elements in nuclear emulsion. It is, for example, extremely important in the study of nuclear reactions to know the identity of the target nucleus. Loaded emulsions, in many cases, make it possible to know the target nucleus with a high degree of probability. Most of the work describing techniques for loading emulsions have been reviewed in several recent books and in the proceedings of these conferences.[1]

A particular problem in loading emulsions has arisen in connection with the production of hyperfragments by K-particles. A considerable insight into the properties of certain hyperfragments and hyperon resonances can be obtained if a target of carbon in the emulsion could be identified with certainty. In the two experiments described herein; first, carbon was introduced into the emulsion in the form of diamond powder and, in the second experiment thin sheets of polystyrene (CH) were placed between two layers of ordinary nuclear track emulsions.

DIAMOND LOADED PELLICLES

Diamond powder was introduced into the emulsion by a number of different techniques. While it is desirable to introduce as much diamond as possible there are a number of severe limitations as to the amount. The first problem is to introduce the powder into the emulsion in such a manner that it is dispersed uniformly throughout the emulsion with no tendency for large clumps to form. Some help in preparing a uniform dispersion was obtained by shaking the diamond powder through a sieve into a well stirred container of liquid emulsion. However, the most effective method by far was to subject a glass beaker of liquid emulsion to high frequency sound vibrations from an ultrasonic cleaner while mixing the diamond powder into it. The melted emulsions with diamonds was kept at a temperature of about 45°C while it was subjected to ultrasonic waves for about 5 minutes. Then it was poured on clean glass plates, chilled quickly, and allowed to dry. Pellicles were then prepared from the dried emulsion and stacks prepared for K-particle experiments.

Several different sizes of diamonds were considered for the experiments. First, diamonds of about 1/2 micron diameter were tried but proved to be too small to allow definitive determination that a nuclear reaction had taken place in the crystal. Diamond crystals as large as 12 microns were tried but the optimum for hyperfragment work was found to be between 4 and 8 microns. Pressure tested prismatic diamonds in this range of sizes were used in most experiments.

There are several limitations on the quality of diamonds which can be placed in the photographic emulsion. While the quantity of diamonds adversely affects the optical properties of the emulsion, the main limiting factor for the concentration proves to be the ability to remove the AgBr from the emulsion in the fixing stage of processing. If the concentration of diamonds is expressed in terms of the percent by weight of the dried emulsion, it is found that fixing becomes excessive when the concentration is greater than 2-3%. The optical properties of the emulsion become rather poor for 2% diamonds and, at this concentration, tracks cannot be followed through pellicles in excess of 200 microns in thickness.

Some pellicles were made in which a layer of 200 micron thick pure G-5 emulsion was prepared and then another 200 micron thick layer of emulsion with 2% diamonds coated on top of it. While a careful use of the layering technique allows an increase in the percent of diamonds in a stack, the deterioration of the optical properties ruled out this approach. The optimum arrangement which was chosen for K-particle experiments was one in which 600 micron thick G-5 pellicles were prepared with a 1% concentration of diamonds 4-8 microns in diameter. An example of a K-particle reaction in one of these pellicles is shown in Fig. 1. As shown in the figure a negative K-particle comes to rest in a diamond crystal and the subsequent reaction in carbon leads to the emission of 4 charged particles. The probability that an emitted track passes through another diamond crystal is sufficiently low so that range measurements are rather reliable.

POLYSTYRENE-EMULSION SANDWICH PELLICLES

Several attempts were made to place a sheet of 12μ polystyrene between two Ilford G-5 emulsions. The principle difficulty was to get the emulsion to adhere properly to the polystyrene sheet. An attempt to pour Ilford G-5 emulsions on both sides of the polystyrene was not too satisfactory. Next, strips of polystyrene were placed in the emulsion during pouring but this too proved not to be fruitful, and attempts to pour emulsion on polystyrene sheets were abandoned.

It seemed that Ilford G-5 pellicles would stick to the polystyrene if the surface of the plastic was treated properly. The first attempts of sanding and cleaning the surfaces with detergents were not successful. Efforts to coat the polystyrene with a base coat of gelatin did not work as it was found that the gelatin solution did not wet the surface of the plastic sheet and excessive use of a wetting agent did not help.

It was finally found that by treating the polystyrene sheet in successively weaker concentrations of H_2SO_4, a gelatin solution could be made to coat the surface. The polystyrene sheet is first placed in a bath of 98% H_2SO_4 for a period of two hours and then into the successive weaker solutions each for a period of two hours. The sheet is then passed through a full strength* gelatin solution at about 28°C and is left to dry overnight. When dry the sheet can be stretched and mounted on a frame and a G-5 pellicle stuck to each side of the sheet using the above gelatin solution. The sticking is done with the frame and the pellicles submerged.

Polystyrene test plates have thus far been exposed to cosmic rays and neutron and proton beams. Preliminary scanning indicates plates comparable to diamond loaded plates. Polystyrene-emulsion sandwich plates may be made that have a much larger percent of carbon than will diamond loaded emulsions.

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* 15 gr. gelatin in 1000 cc of water
5 cc glycerin   0.5 cc wetting agent

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CAPTIONS

Fig. 1. Microprojection drawing of negative K-particle stopping in a diamond crystal.

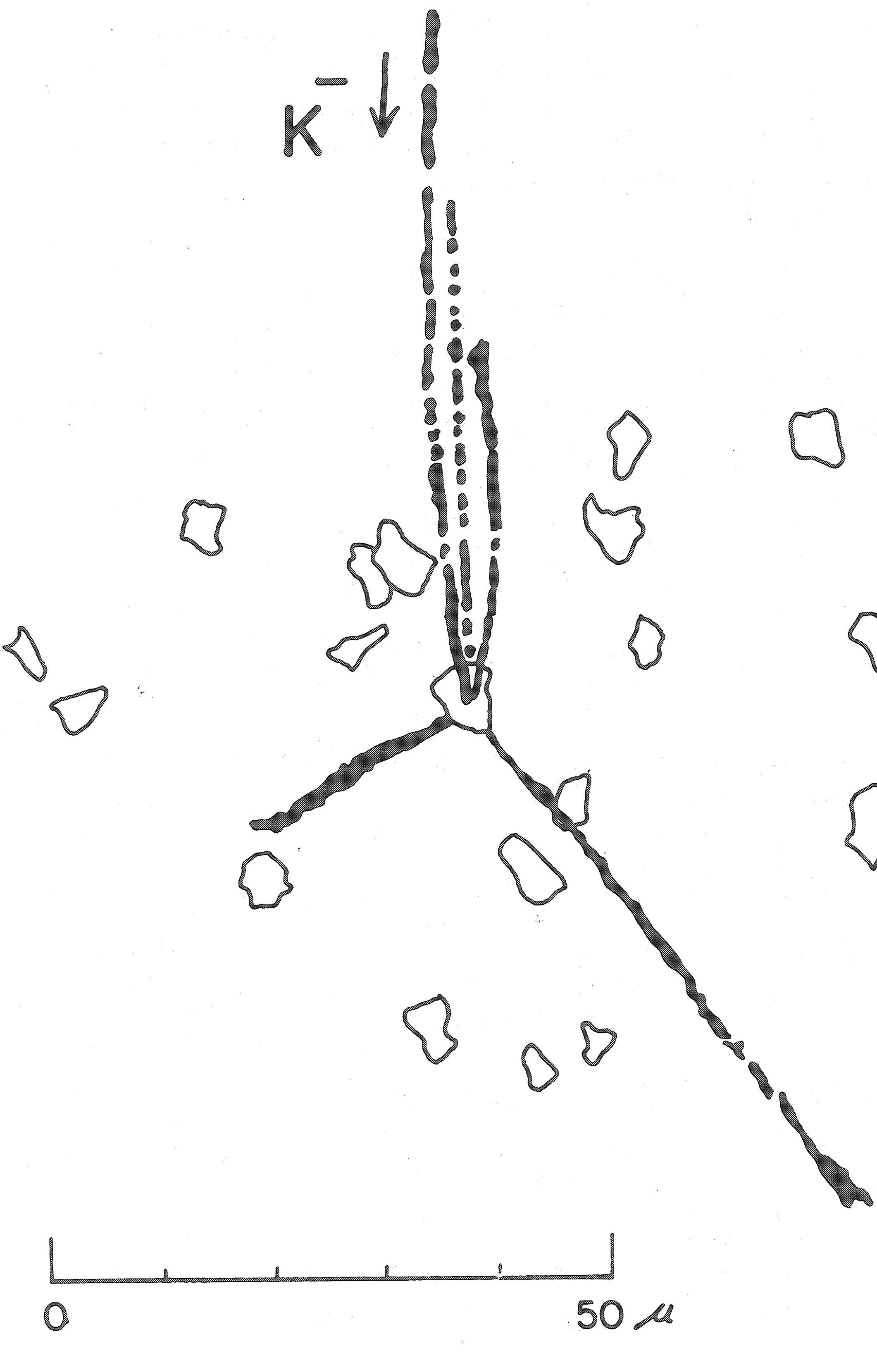

fig. 1