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Abstract

We describe the manufacture of a source of 5.5 MeV alpha particles collimated with gold foil to a width of 35 μm. The source width was measured by using nuclear emulsions and by using a multi-wire liquid xenon ionization chamber.

In a study of the space resolution obtainable with a liquid xenon wire chamber,[1,2] it was necessary to fabricate a well-collimated source of alpha particles. The source holder was to be the flat surface of a microscope objective lens which also served as the cathode of the liquid xenon test chamber (see Fig. 1). The fabrication consisted of five steps: cutting a slot 30 μm deep and 15 μm wide into the quartz objective, preparing an 8 μm diameter radioactive wire, wedging the wire into the slot, applying a conductive coating to the lens, and then glueing a piece of gold foil 15 μm thick on each side of the slot.

A brass disc 0.050 in. thick and 1.25 in. diam was mounted on a 10 in. metal lathe. The edge of the disc was sharpened so that it had an included angle of 15 degrees. The rotating disc was brought to the surface of the quartz, and diamond dust of 8,000 grit (approx 2 μm in diam) was applied as the slot was formed. In order to keep the cutting edge of the disc true to its axis of rotation, the disc mounting was not disturbed between the sharpening and cutting operations. Previous attempts to make the slot by using a razor blade in an ultrasonic drill or by using a rotating sharpened steel disk produced slots with rough edges. The brass disk was superior because the diamond grit became embeded in its surface.

A platinum wire 13 μm diam and 10 mm long was prepared by repeatedly plating it with ^{241}Am, followed each time with a 900°C bake for 10 sec until the activity reached 3×10^5 counts per minute. The objective lens was masked with gummed plastic tape, leaving only the slot that would receive the wire. A piece of the radioactive wire, approx 800 μm long, was cut off and wedged into the slot with a dulled razor blade. The last operation was done with the aid of a microscope

in an open front hood; the operator wore gloves, apron, and respirator for prevention of possible contamination. The objective was heated to 500°C in a furnace, and then stannous chloride vapor was blown onto it to produce a conductive coating of 500 to 1,000 ohms per square. A scanning electron microscope was used to check the slot width and depth, as well as the position of the wire.

The source was tested mechanically by tapping it on a hard surface, by blowing air onto it from a 100 psig supply and by repeated emmersion in liquid nitrogen. The wire remained securely lodged in place.

Two pieces of gold foil 1 mm$\times$1 mm in size and 10 μm thick were positioned on each side of the slot. The foils were held in place with small weights as Eastman Kodak 910 cement was allowed to spread between the foil and the quartz.

A nuclear emulsion was used to verify that the source had been collimated to 35 μm (see Fig. 2). The source distribution was also measured by using a multi-wire liquid xenon ionization chamber.[2] The measurement shown in Ref. 2 was made using a source which did not have the gold foil collimation. Consequently, the source was seen to have a width of 50 μm.

This source provides a count rate of 30 alphas per second. A source with similar characteristics could be achieved by vacuum deposition of a coating of ^{241}Am on the quartz and then collimating with gold foil, but a surface intensity of 10^7 counts/min/sq mm would be required. Vacuum deposition is thus extremely inefficient when compared to the method of electroplating the source onto a small wire and then inserting the wire into a groove.

We thank Harry Heckman and Robert Smith for providing us with nuclear emulsions and advice on their use. Work done under the auspices of the U. S. Atomic Energy Commission and the National Aeronautics and Space Administration.

References

[1] Luis W. Alvarez, The Use of Liquid Noble Gases in Particle Detectors, in Group A Physics Note 672, Nov. 1968, Lawrence Berkeley Lab.

[2] Richard A. Muller, Stephen E. Derenzo, Gerard Smadja, Dennis B. Smith, Robert G. Smits, Haim Zaklad, and Luis W. Alvarez, Phys. Rev. Letters 27, 532 (1971).

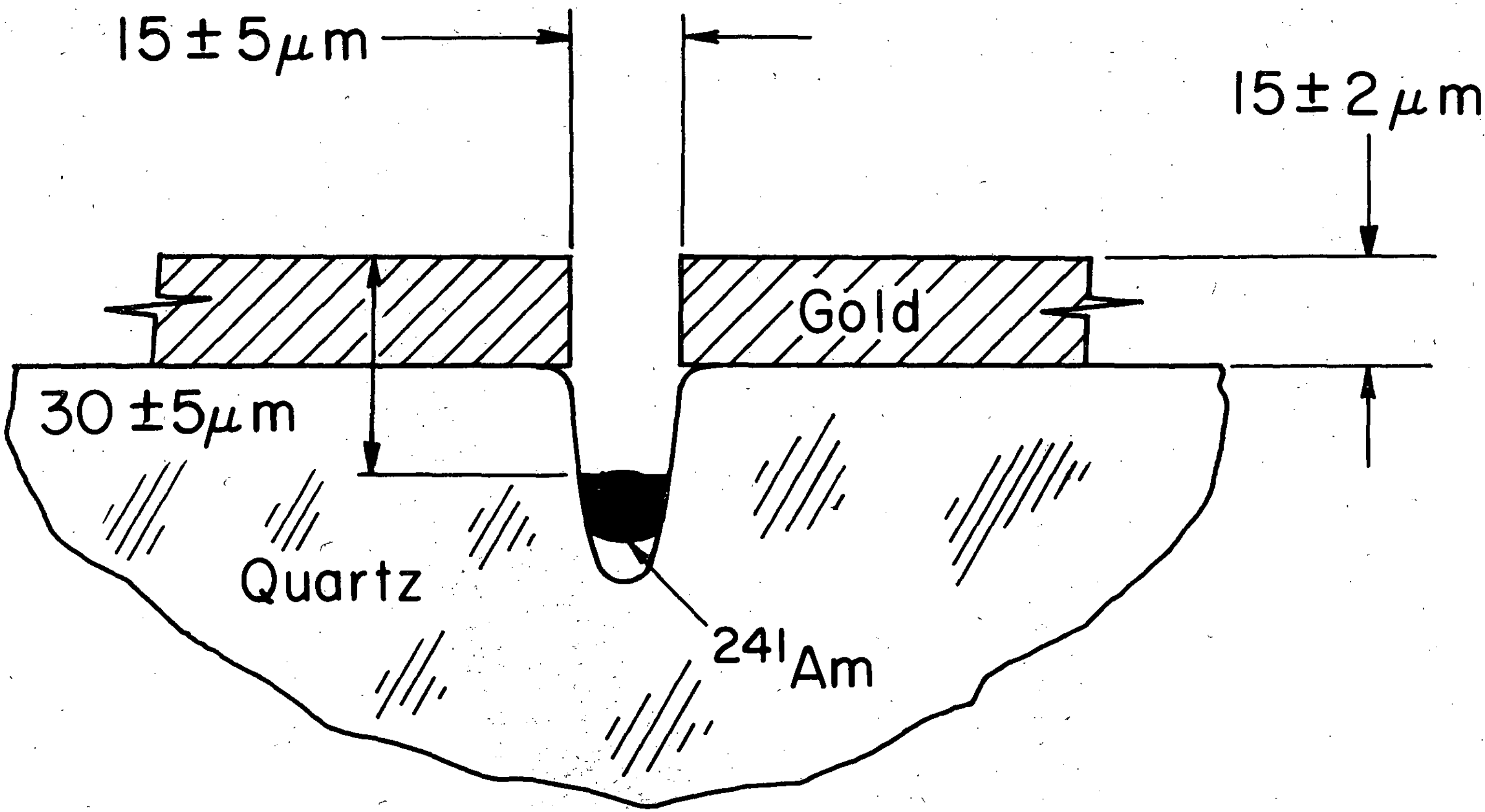

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Fig. 1. Structural detail of collimated alpha source.

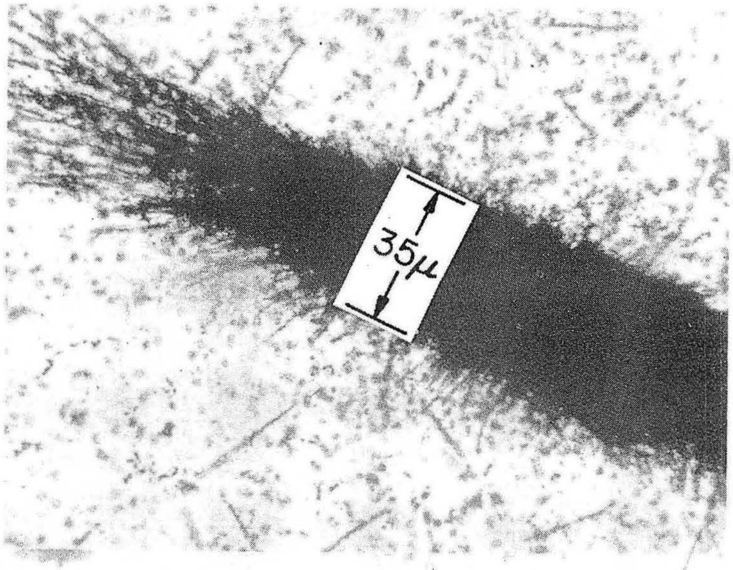

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Fig. 2. Photomicrograph of alpha tracks in nuclear emulsion to verify width of collimated alpha source.

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