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AEC Research and
Development Report

Knolls
Atomic Power
Laboratory

An Alpha Counter for Uniformity Measurements

F. A. White
J. C. Sheffield
July 1, 1957

Operated for the
United States Atomic
Energy Commission by
GENERAL ELECTRIC

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UC-37, Instruments
(TID-4500, 13th ed)

General Electric Company
KNOLLS ATOMIC POWER LABORATORY
Schenectady, New York

AN ALPHA COUNTER FOR UNIFORMITY MEASUREMENTS

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Authorized Classifier

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ABSTRACT

An ionization-type alpha counter is used to measure the uniformity of thin coatings of alpha-emitting materials to $\pm 1\%$ exclusive of statistical error. The (n,α) reaction allows the counter to be used for measuring the uniformity of B-10 foils when a suitable neutron source is provided.

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AN ALPHA COUNTER FOR UNIFORMITY MEASUREMENTS

F. A. White and J. C. Sheffield

Thin, uniform foils are required for many nuclear experiments. The importance of uniform density films of fissionable material in neutron beam experiments has been demonstrated in cross-section determinations.* In neutron beam work it is also sometimes necessary to assay thin targets of boron enriched in the B-10 isotope. The (n,α) reaction allows measurements of surface density and uniformity of boron films with the alpha-counter described in this report if the base is mounted on a suitable paraffin-moderated radium-beryllium or polonium-beryllium neutron source. A method is described here for measuring the uniformity of foils that are alpha emitters. The apparatus may be adapted for either a high or low geometry depending upon the sample activity. In either case, the uniformity may be measured to $\pm 1\%$, exclusive of statistical error.

A photograph of the high geometry assembly is shown in Figure 1. Two revolutions of the graduated knob "A" provide 360-deg rotation of the foil holder "B". Lateral motion of greater than half the diameter of the foil is provided by a slotted driving screw and graduated collar at "C". Thus, any area of the foil may be positioned with respect to the aperture in ionization chamber "D" in a polar coordinate frame of reference.

The ionization chamber is a parallel-plate type with the collector plate tied directly to the input grid of the preamplifier "E". The geometry may be changed by substituting one of several high-voltage plates with various sized apertures. A negative 600 volts is applied to this plate through the connector at "F". A grounded guard ring, not shown in the photograph, is mounted around the outside of the lucite insulator separating the parallel plates. The guard ring prevents the collection on the collector plate of any ionization external to the volume between the parallel plates. Since all the particles passing through the aperture have nearly normal incidence, the resulting output pulses are nearly equal in amplitude and can be easily counted.

*Friesen, W. J., Leonard, B. R., Jr., Seppi, E. J., and White, F. A., "Comparison of the U-235 Fission Cross Section to the Au-197 Capture Cross Section," Bull. Am. Phys. Soc., Ser. II 1, 249 (1956).

For good geometry, that is, maximum counting rate over a minimum area, the spacing between aperture and foil must be as small as possible. A minimum of 30 mils was selected to prevent arcing to the foil. Vertical motion is imparted to the chamber by the calibrated gear assembly at "G". One revolution of an indicator dial on this assembly represents a 40-mil movement of the chamber. Contact with the foil assembly, "H", is made by a small protrusion on the edge of the aperture via the high-voltage lead. The contact point was found to be reproducible to within 2 mils, thus allowing accurate determination of the spacing at any position on the foil.

Neoprene O-rings on the driving shafts and a gasket on the base make a vacuum-tight seal after the two halves are assembled. The housing is evacuated and then filled with a mixture of argon and CO₂ gas through the valves on the base to a pressure of about 120 cm Hg.

For high activity samples, a low geometry adaptor (not shown) is mounted on the same base assembly. To a second base flange is attached a 3-in.-diam pyrex cylinder 5 in. in height on top of which is waxed the negative high voltage electrode. This electrode is a circular plate perforated with several holes and covered by 0.5-mil nylon so that the cylindrical region between the alpha source and negative high voltage electrode may be evacuated. An outer metallic housing is concentric with this pyrex cylinder and the preamplifier is mounted on the former unit. The collector plate is suspended from the preamplifier at a distance of approximately 7/16 in. from the negative high voltage electrode. The intervening region is filled with an argon-CO₂ mixture at 1 atm.

A comparison was made of the above method with uniformity measurements by photographic emulsion techniques. A standard 1 x 3 in. alpha sensitive plate is masked from the alpha source by means of the collimating plate I, also shown in Figure 1. After the plate is developed, the alpha tracks from each hole are observed and counted by means of a microscope. This procedure is long and tedious and less accurate than the alpha scanner, although the results are in good agreement with the electronic scanner.

Conventional amplifiers, pulse height discriminators, and scaling units are employed for recording the output pulses of the scanner. Good discriminator plateaus are attained from either the high or low geometry chambers.

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FIGURE 1 ALPHA COUNTER COMPONENTS

A. Turn-table rotor	D. Ion chamber	G. Vertical drive
B. Foil holder	E. Preamplifier	H. Foil holder assembly
C. Translational drive	F. High-voltage connector	I. Nuclear emulsion
plate holder

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