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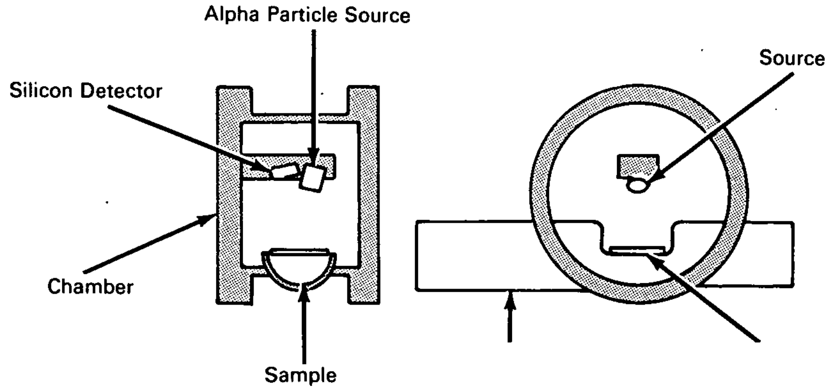
## Alpha Particle Backscattering Measurements Used for Chemical Analysis of Surfaces




**The problem:**

To perform a chemical analysis of surfaces using alpha particle backscattering. Alpha particle sources and detector equipment presently available to measure particle backscattering do not permit determination of elements present in the target material.

**The solution:**

An apparatus which incorporates a $Cm^{242}$ (curium) source and a semiconductor detector to determine the energy spectrum of backscattered alpha particles. The energy spectrum of the backscattered alpha particles is characteristic of the elements present in the target material, thus permitting the chemical composition of the surface to be determined.

**How it's done:**

The alpha particle source and semiconductor detector are mounted in an evacuated chamber which has a vacuum lock for introducing samples. The source is oriented such that the beam of alpha particles will hit the surface of the sample to be analyzed. The detector is oriented such that those alpha particles which are backscattered through a certain fixed angle will fall on the detector.

A $Cm^{242}$ alpha particle source is prepared from neutron-irradiated $Am^{241}$ (americium) by purification and then electrodeposited onto platinum disks. This source is highly monoenergetic when first prepared and gives an ideal alpha particle source for backscattering measurements. However, the decay products of $Cm^{242}$ emit alpha particles of other energies, so that after several half-lives it cannot be used to obtain accurate measurements.

The detection system consists of a reverse-biased, surface-barrier silicon detector connected to an amplifier system and a pulse-height analyzer. When an alpha particle hits the silicon detector, an electric pulse of a magnitude proportional to the energy of the alpha particle is formed. This pulse is first amplified and then fed into the pulse-height analyzer. Essentially, the pulse-height analyzer counts and records the number of pulses at each possible pulse magnitude.

The detection system records the number of alpha particles which hit the detector for each possible alpha

(continued overleaf)

particle energy. This can be plotted on a graph of number of particles versus energy of alpha particles, and for a particular element in the sample, the plot will be a step function. The step location on the graph is characteristic of the particular element, and the element identity can be calculated using the Rutherford scattering equations or can be determined by comparison with test data on known materials.

If there are two elements present in the sample, then the characteristic curves of each element will be superimposed on the other. Thus, by an analysis of the curves which result from the backscattering measurements, the particular elements present can be determined.

**Notes:**

1. For certain elements, protons are produced from nuclear reactions which occur when the alpha particles react with various nuclei in the sample. The detection of these protons in a way similar to the detection of scattered alpha particles can increase the sensitivity of the method for these elements.
2. The method of analysis described is particularly applicable to the light elements where other techniques, such as X-ray fluorescence, cannot be used.
3. Additional details are contained in: *J. Geophys. Res.* vol. 70, No. 6, 1311-1327, March 15, 1965.
4. Inquiries concerning this innovation may be directed to:

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    Reference: B67-10186

Source: J. H. Patterson
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**Patent status:**

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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