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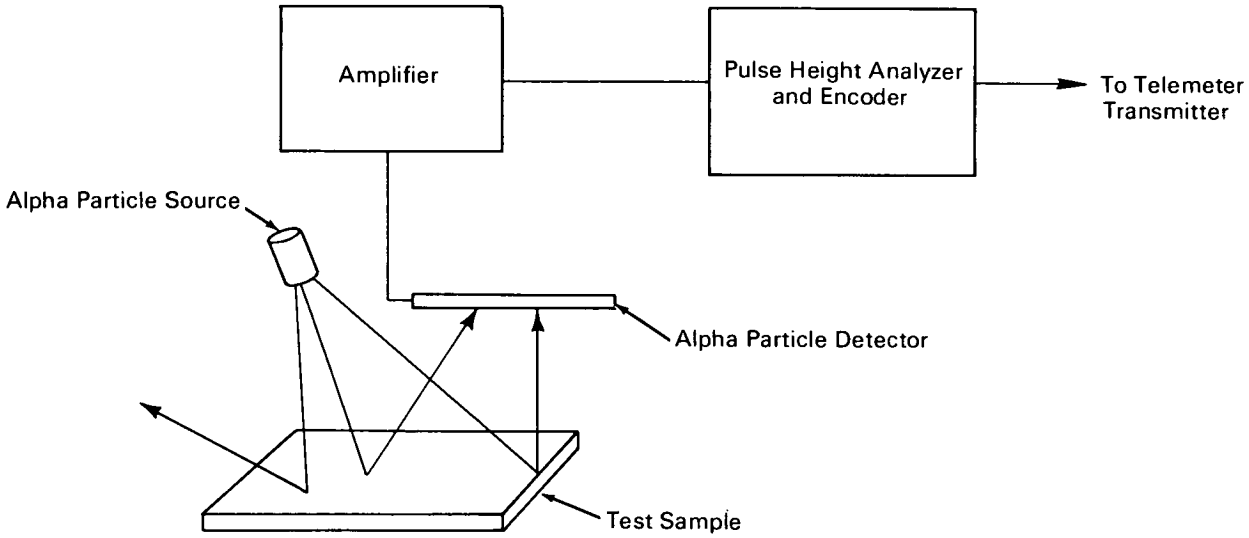
NASA TECH BRIEF

Instrument Performs Nondestructive Chemical Analysis; Data Can Be Telemetered



The problem: Devising a lightweight instrument for nondestructive chemical analysis of surfaces. The instrument must automatically perform the analysis and provide the resultant data in the form of electronic signals which can be transmitted to remote sites. Such an instrument was particularly required for chemical analysis of lunar and planetary constituents and transmission of the data via telemetry to receiving stations on the earth.

The solution: An instrument employing simplified solid-state nuclear particle detectors in conjunction with a source of charged nuclear particles and an electronic pulse-height analyzer. The scattering of the charged particles from the atomic nuclei in the sample result in characteristic spectra.

How it's done: For relatively low-energy particles, such as alpha particles from the usual radioactive sources, and for those elements that are heavier than aluminum, the large-angle scattering of heavy charged particles is primarily Rutherford scattering. For light elements such as carbon and oxygen, and particularly with rather high-energy alpha particles such as those from Cm^{244}, nuclear effects enhance the scattering above that predicted from pure Rutherford scattering. For other light elements, such as nitrogen and fluorine, protons from (alpha, proton) reactions can also be expected.

The analysis of solids (the top 1 to 100 microns) is best conducted in a vacuum. A monochromatic, collimated beam of charged particles (e.g., alpha particles from a thin radioactive source) bombards the surface

(continued overleaf)

of the sample. Some of the charged particles scattered from the atoms (Rutherford scattering) within the sample strike the surface of a small solid-state (surface-depletion-type) detector placed at a high scattering angle (160° average) approximately 3 centimeters above the surface of the sample. The amplified pulses from the detector are converted into a particle count-energy spectrum. This spectrum may be encoded and telemetered to give analytical information on the kinds and amounts of elements present in the test sample.

Notes:

1. Previous experimental detector systems described in the literature have employed cumbersome and complex magnetic spectrometers. The novelty of this instrument lies in the use of a simplified solid-state detector system. As designed for use in the analysis of planetary constituents, the entire instrument weighs approximately eight pounds.
2. With some modification the instrument can be adapted for nondestructive chemical analysis of surface films, gases, and solid samples in laboratories or in chemical process industries.
3. Further information concerning this innovation is described in "Chemical Analysis of Surfaces by Use of Large-Angle Scattering of Heavy Charged Particles", by Anthony Turkevich, *Science*, *134*, 672, 8 September 1961. Inquiries may also be directed to:

   Technology Utilization Officer
   Jet Propulsion Laboratory
   4800 Oak Grove Drive
   Pasadena, California, 91103
   Reference: B65-10317

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated by NASA.

Source: Enrico Fermi Institute for Nuclear Studies, University of Chicago, under contract to Jet Propulsion Laboratory (JPL-SC-078)