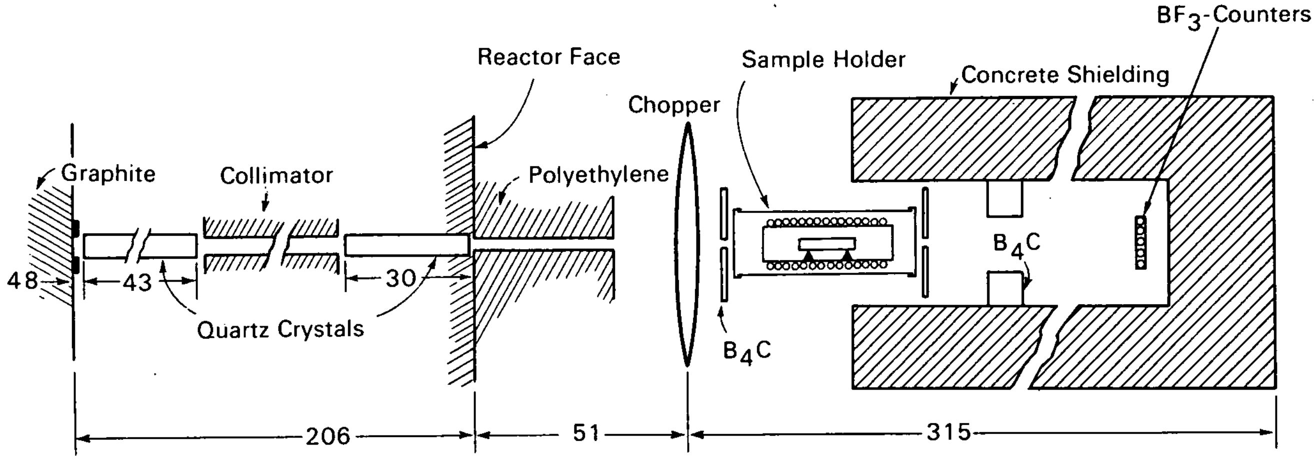
AEC-NASA TECH BRIEF

Analyses of SiO_2, MgO, PbF_2, Bi as Low-Pass Velocity Filters for Neutrons



The experimental arrangement; dimensions are in centimeters.

Measurement of transmission of neutrons by various filter materials for low-energy neutrons, including cooled and enriched SiO_2, MgO, Bi, and PbF_2, has been reported (*1*).

The techniques of neutron diffraction and neutron inelastic scattering are widely used for study of the structure and dynamics of condensed matter, constituting the major use of the neutron beams from research reactors. Only the thermal neutrons from a reactor are useful for such experiments; the fast neutrons and gamma rays emitted are only an unwelcome background. Thus materials serviceable as filters, transmitting thermal neutrons while attenuating fast neutrons and gamma rays, are of considerable interest.

Transmission of monochromatic slow neutrons was studied at wavelengths from 1 to 5 Å by monocrystalline and polycrystalline samples of SiO_2 (quartz), MgO, PbF_2, and Bi at 83° and 300°K. These materials were selected as apparently suitable for use as "low-pass" velocity filters for neutrons.

The results indicate that cooled single crystals of MgO are remarkably transparent to thermal neutrons; more than 80% of the incident 2-Å neutrons are transmitted by a 15-cm sample whose transmission for 1- to 2-Mev neutrons is of the order of 10^{-2}. Quartz (SiO_2) is almost equally effective as a filter material. Measurements with Bi show that (i) transmission is low and quite variable from sample to sample for neutron wavelengths between 1 and 2 Å, and (ii) transmission is fairly high for wavelengths greater than 4 Å (50% for a 15-cm sample). For the latter range of wavelengths, slowly-cooled Bi castings, in which large grains have developed, are about as transparent as (nominally) monocrystalline samples. A single

(continued overleaf)

crystal of PbF_2 exhibits markedly higher transmission in the range between 1 and 3.5 Å than does any Bi sample.

In the analysis, the conventional time-of-flight technique was used on a low-power (200-kw) reactor moderated by H_2O (Fig. 1). To reduce the troublesome background of unmoderated fission neutrons, quartz crystals were used as a beam filter; the beam passed through 43 cm of uncooled crystals near the source end of the beam tube as well as 30 cm of liquid-nitrogen-cooled crystals near the outer end of the tube.

The beam was collimated to 1.5° vertically and 0.9° horizontally. The detector subtended 2.3° in each plane so that small-angle scattering effects did not appear to any great extent in the data. The time-of-flight resolution was approximately 40 μsec/m. Background corrections were typically a few tenths percent and never more than 10% of the transmitted intensity. The overall system and procedures were checked by transmission measurements on Au foils; results were in close agreement with those expected from known foil weights and the accepted value of the Au cross section.

Reference:

1. S. Holmryd and D. Connor, *Rev. Sci. Instr.* **40,** 49 (Jan. 1969); the theoretical basis for neutron filtration by crystalline materials is briefly discussed

Notes:

1. This information should interest those concerned with neutron diffraction for defect studies.
2. Inquiries may be directed to:

Office of Industrial Cooperation
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439
Reference: B69-10211

Source: S. Holmryd and D. Connor
Solid State Science Division
(ARG-10220)

Patent status:

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

Mr. George H. Lee, Chief
Chicago Patent Group
U. S. Atomic Energy Commission
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439