THE DIFFRACTION OF NEUTRONS BY CRYSTALLINE POWDERS

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Introduction

Diffraction effects produced when a beam of slow neutrons falls on a crystalline substance have been demonstrated many times in the past decade. In general these experiments have made use of single crystals since then, the diffracted intensity is considerably enhanced over that when a crystalline powder is used. There are, however, several reasons for working with crystalline powders in spite of the much-reduced intensity obtainable, notably that (a) relative intensity data can be obtained without extinction and crystal perfection ambiguities and (b) substances can be examined which are generally not available in single crystal form. The performance of such experiments has, of course, become possible only since the advent of chain-reacting piles with their accompanying intense beams of collimated neutrons. The experiments to be described are more or less introductory to the general problem of the effect upon the intensity of diffraction of various nuclear and crystalline properties.

Experimental Technique

A schematic diagram of the equipment used in studying neutron diffraction effects is given in Figure 1. A collimated beam of slow neutrons is passed out through the radiation shielding of the Clinton pile and falls upon a monochromating single-crystal of sodium chloride. This crystal is oriented so as to Bragg-reflect neutrons of wavelength 1.08 augstroms (energy 0.069 electron volts). After collimation through slits of size 1 cm by 3.5 cm, the monochromatic beam strikes a flat plate of the crystalline powder under study mounted on a spectrometer table. Detection of the diffracted radiation is accomplished with an enriched $B^{10}F_3$ proportional counter of two-inch diameter and 20-inch length. The efficiency of this counter to neutrons of wavelength 1.08 augstroms is about 60 percent. The neutron current in the primary monochromatic beam is about 10^6 neutrons per minute and in the diffraction peaks about 30 - 100 neutrons per minute. In spite of rather heavy shielding of paraffin, B_4C and cadmium around the counter, the counter background (with the primary beam stopped off) amounts to 50 or 60 counts per minute. This background varies both in time and counter position and it has been found necessary to take alternate readings with and without a cadmium filter. Figure 2 shows a photograph of the diffraction spectrometer.

Experimental Results

I. Carbon Series

Three different structural forms of carbon namely: diamond, graphite and charcoal, have been examined and typical diffraction patterns for these are shown in Figures 3, 4 and 5. It is to be noted that an appreciable amount of diffuse scattering is present even in the case of diamond. This diffuse scattering has been studied over a considerably range of scattering angle and as is seen in Figure 6 it appears to be isotropic. From the intensity of the diffraction peaks and the diffuse scattering it is possible to calculate coherent and