JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN VOL. 17, SUPPLEMENT B-II, 1962
PROCEEDINGS OF INTERNATIONAL CONFERENCE ON MAGNETISM AND CRYSTALLOGRAPHY, 1961, VOL. II

# Neutron Diffraction Research in Australia

T. M. SABINE

*A.A.E.C. Research Establishment, Lucas Heights N.S.W., Australia*

## 1. Introduction

The Australian high flux research reactor Hifar first operated at full power in March, 1960. Since that time three neutron spectrometers have been installed and several pieces of research commenced. In this paper the spectrometers are described and the work in progress discussed.

## 2. Apparatus

*Single crystal spectrometer*: A collimator was inserted in a horizontal hole (4*H*2). It extracts a beam $\frac{1}{2}$ inch$\times\frac{1}{4}$ inch with a divergence of 30 minutes and an intensity at the reactor face of $2.5\times10^8$ n/cm²/sec. A single crystal diffractometer similar to those installed by Dyer at Harwell is mounted on a shield which can rotate about the monochromator crystal so that the wavelength of the monochromatic beam incident on the specimen crystal is variable.

To allow for reactor variations, which can be considerable, the spectrometer is controlled by a monitor counter in the beam from the monochromator. When a preset number of counts have been received by the monitor channel the number received by the detector channel is printed on tape and the counter and crystal moved through a preset angle.

No attempt has been made to automate this spectrometer; reactor shift staff change crystal and counter positions at the request of the experimenter.

*Powder spectrometer*: The powder spectrometer is installed on a similar horizontal hole with a larger collimator. The beam size is $\frac{1}{2}$ inch$\times$1 inch. The monochromatic beam exit tube is fixed at 30° to the collimator centre line. The spectrometer was constructed from a naval gun mount and the counter moves at a rate of 8° of $2\theta$ per hour.

This spectrometer has unusually good resolution characteristics. A comparison between experimental line width variation with

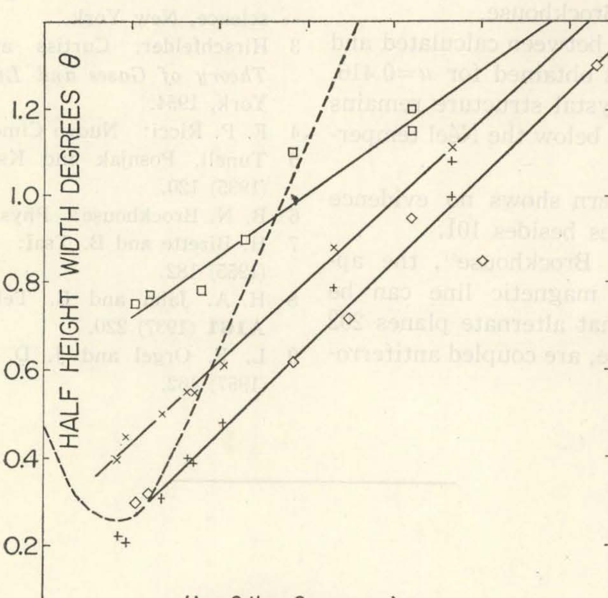


Fig. 1.

$2\theta$, and the variation expected from the analysis of Cagliotti *et al*[1] is shown in Fig. 1.

*Long wavelength spectrometer*: A simple spectrometer has been set up for experiments with sub-thermal neutrons. A mica diffracting crystal is used with Be and BeO filters. Use of a graphite filter was planned initially to extend the wavelength range beyond 9Å but none of the available types of graphite showed transmissons approaching those given in the literature. Accordingly a simple chopper has been constructed to extend the wavelength range.

## 3. Research

*Thermal spectrum of Hifar*: As a necessary preliminary to neutron diffraction work the reactor thermal spectrum was determined by crystal spectrometry. The peak was found to be at 384±10°K.

*The scattering of long-wavelength neutrons by Irradiated BeO*: The technique first used by Antal, Weiss and Dienes[3] for graphite and later by Antal and Goland[4] for $Al_2O_3$ was used to study defect production in irradiated BeO. The variation in log $(I_u/I_i)$ when $I_u$ is the transmission through an unirradiated specimen 14 cm long and $I_i$ the transmisson through an identical irradiated specimen is shown in Fig. 2. Fig. 3 shows the behaviour of the extra-attenuation with annealing temperature. The initial dip past the Bragg cut-off has not been satisfactorily explained but it is unlikely to be distortion of the cut-off by the broadened (002) line [(100) does not broaden under irradiation] since this broadening does not anneal out until 1400°C.

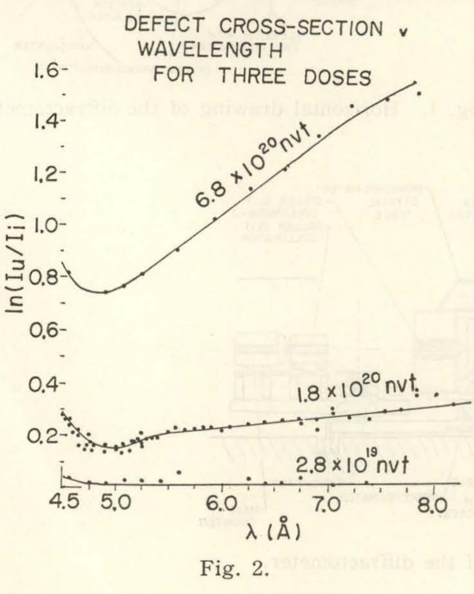


Fig. 2.

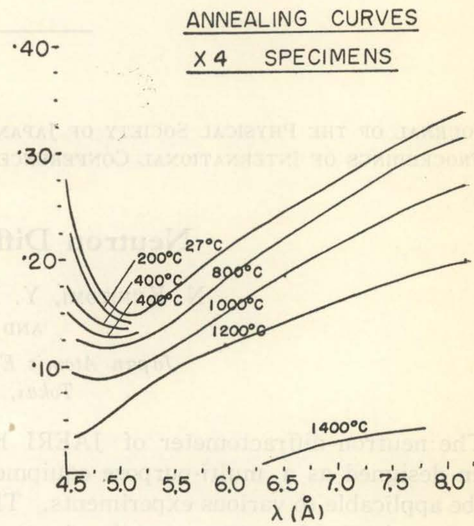


Fig. 3.

The theory of the scattering of X-rays by polyatomic gases has been applied to the steep increase in extra-scattering with wavelength. The experimental results are fitted by a model in which the vacancies are close packed into spherical clusters containing fourteen defects and the interstitial atoms are randomly distributed.

It is unlikely that the defects are in fact clustered as spheres since the X-ray line broadening is extremely anisotropic; X-ray line broadening and electron microscope studies are being carried out to supplement the neutron results.

*Interstitial solid solution in the Zr–Ti–O system*: The structures of alloys in the Ti–Zr–O and Ti–O systems are being examined in order to determine whether any long range ordering of the oxygen atoms occurs at low oxygen concentrations. The Ti–Zr alloy chosen initially was the null-matrix alloy (38% Zr, 62% Ti). Addition of 10% oxygen produced a strong diffraction pattern which has been indexed as b.c.c. with $a = 5.65$ Å.

*The magnetic structure of NiO*: This structure was initially examined in 1958[2] and is being repeated on the Hifar single crystal spectrometer where the signal to background ratio is considerably better.

### References


1 Caglioti, Paoletti and Ricci: Nucl. Inst. **3** (1958) 223.
2 T. M. Sabine: A. A. E. C./E46 (1959).
3 J. J. Antal, R. J. Weiss and G. J. Dienes: Phys. Rev. **99** (1955) 1081.
4 J. J. Antal and A. L. Goland: Phys. Rev. **112** (1958) 103.


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# Neutron Diffractometer JAERI

N. KUNITOMI, Y. HAMAGUCHI, M. SAKAMOTO AND S. KOMURA

*Japan Atomic Energy Research Institute*
*Tokai, Ibaraki, Japan*

The neutron diffractometer of JAERI has been designed as a multi-purpose equipment to be applicable to various experiments. This is not only used as a conventional powder specimen type neutron diffractometer but also as a single crystal specimen type diffractometer, as a polarized neutron diffractometer, and as a rotating crystal neutron spectrometer. This has been installed on JRR-2, which is a CP-5 type 10 MW nuclear reactor with the maximum expected thermal neutron flux of $1\cdot10^{14}/\mathrm{cm}^2\cdot\mathrm{sec}$. The horizontal beam hole H-10 with the measured thermal neutron flux of $3\cdot10^{12}/\mathrm{cm}^2\cdot\mathrm{sec}$ at 1 MW operation is used for our instrument. Since the fuels in front of H-10 is not inserted at 1 MW operation, its neutron flux is expected to increase beyond the ratio of powers at the operation of the higher levels.

The horizontal and vertical drawings of the instrument are shown in Fig. 1 and Fig. 2, and the photographic view is shown in Fig. 3. The operation and the control of this instrument are fully automatized and the other specifications are as follows:

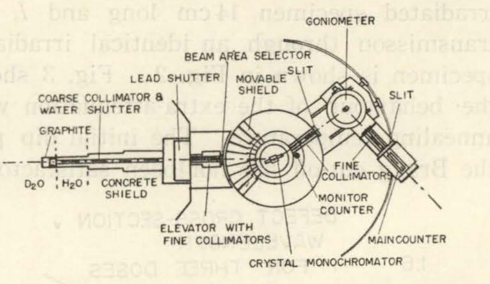


Fig. 1. Horizontal drawing of the diffractometer.

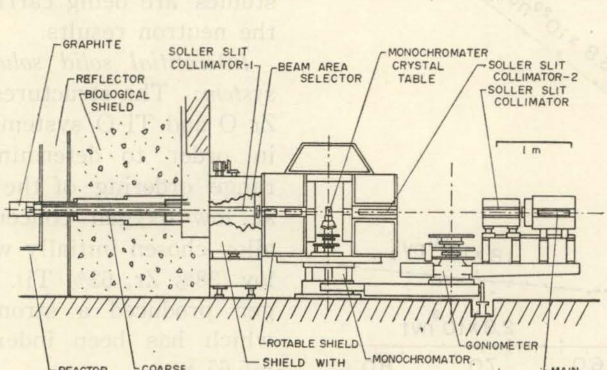


Fig. 2. Vertical drawing of the diffractometer.