ADVANCED MATERIALS

Research News

Beryllium Crystals for Neutron Monochromators

Since the introduction of neutron diffraction for the investigation of condensed systems, beryllium has been known as the most efficient material for thermal neutron monochromators. Additionally, a great demand has grown in recent years for beryllium single crystals as X-ray monochromators. Compared to the common neutron monochromator materials such as copper, silicon and niobium, beryllium crystals yield a distinctly higher intensity of the monochromated neutron beam. In most cases high reflectivity of the monochromator is not demanded for a distinct wavelength only, but for a small wavelength range. Therefore, the monochromator crystals should have a uniform distribution of dislocations, the so-called mosaic spread, throughout the bulk.

For a long time no single crystals of a sufficient size and with the desired mosaic spread were available because of difficulties in crystal growth.[1] Using a double ellipsoid mirror furnace, developed at the Crystallographic Institute of the University of Freiburg,[2] *Jönsson* succeeded in growing a small crystal by crucible-free zone melting.[3] Encouraged by this success, several neutron scattering laboratories joined the collaborative team formed by the Institute Laue-Langevin, Grenoble, and the Max Planck Institute for Metals Research, Stuttgart, in 1984.[4] In 1987 the Rheinisch-Westfälische Technische Hochschule Aachen also joined in this project.

A double and a triple ellipsoid mirror furnace were constructed, using designs developed in the universities of Freiburg and Stuttgart.[2, 5] The growth conditions, described and discussed in deteil recently,[4], were steadily improved. In particular it became necessary to incorporate a complex purification process to radically reduce the high beryllium oxide content which interferes with crystal growth.

At present, crystals of 15 to 17 mm in diameter and 50 to 70 mm in length can be grown. Their quality is checked by

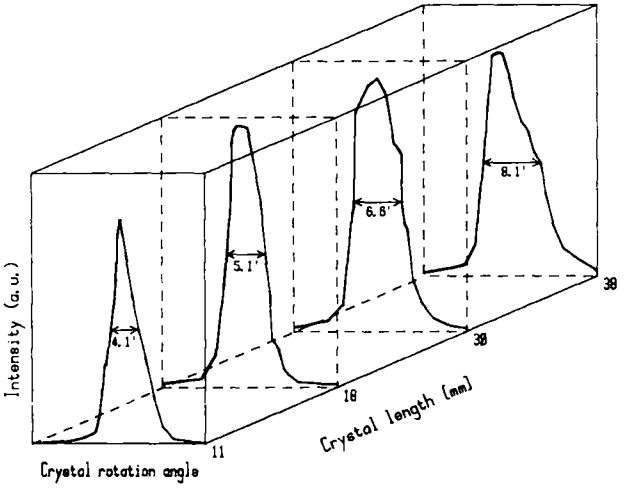

Fig. 1. Neutron rocking curves for different crystal lengths.

Laue transmission photographs, by X-ray, γ-ray and neutron diffraction, and by neutron topography. Figure 1 shows a typical series of neutron rocking curves for different crystal lengths. Plastic deformation techniques are now being studied in order to obtain the desired mosaic spread of 15′ to 30′. The construction of the first beryllium monochromator, using some thirty beryllium crystals, will soon be achieved.

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[1] S. Jönsson, *J. Cryst. Growth 63* (1983) 116.
[2] A. Eyer, R. Nitsche, H. Zimmermann, *J. Cryst. Growth 47* (1979) 219.
[3] S. Jönsson, *Deutsche Gemeinschaft für Luft- und Raumfahrt, Report 82-02*, Bonn 1982, p. 83.
[4] S. Stiltz, A. K. Freund, *J. Cryst. Growth 88* (1988) 321.
[5] S. Stiltz, S. Jönsson, *Metall 38* (1984) 748.