Neutron time-of-flight texture measurements in Dubna: Status and developments

Vortrag

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Introduction

The multidetector texture diffractometer SKAT (from Russian: *Spektrometer Kolitshestvennovo Analiza Tekstury*) at the pulsed reactor IBR-2 in Dubna, Russia, started operation in March 1997 and is open for users from all countries. Application of time-of-flight (TOF) diffraction to texture measurements offers the opportunity to record complete diffraction patterns, i.e., to measure several pole figures simultaneously (Fig. 1(a)). To allow high spectral resolution for measurements on polyphase geological samples with many diffraction patterns, the instrument was placed at the end of an over 100 m long flight path. In this paper, we will summarize advantages and disadvantages of the SKAT, as well as intended improvements.

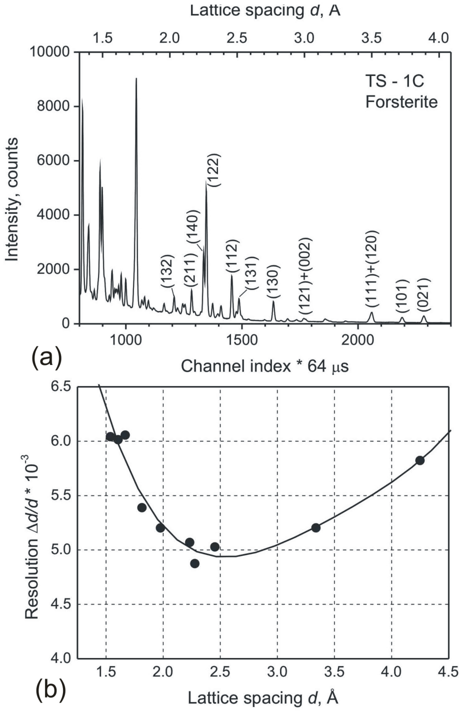

Figure 1: (a) Time-of-flight diffraction pattern of olivine (forsterite). Some Bragg reflections are indicated. (b) Best possible experimental resolution $\Delta d/d$, determined on quartz powder sample.

Characteristics of the SKAT — advantages and disadvantages

The main characteristics of the SKAT are as follows (Ullemeyer et al. 1998, Fig. 2):

- 19 detector modules are arranged around the incident neutron beam at a unique angle of $2\Theta = 90°$. Particular Bragg peaks are assigned to one and the same neutron wavelength λ, hence, all λ and Θ dependent intensity corrections may be avoided.
- The sample is positioned in the centre of the detector ring and rotated around an horizontal axis Z at an angle of 45° with respect to the incident neutron beam. Supposing that the detector modules include an angular range of 180°, complete pole figures may be measured by a single sample revolution (measurements are fast).
- The goniometer angle of 45° allows installation of axial symmetric sample environment with minimum restrictions to the incident and diffracted beams.

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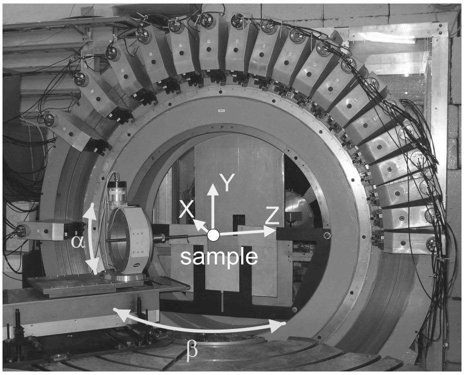

Figure 2: Photograph of the SKAT. Planned sample motions around X (α) and Y (β) are indicated.

- Due to the long flight path, high resolution may be achieved by collimation of the diffracted beam (Fig. 1 (b)).
- The beam cross section of $50 \times 85\,\mathrm{mm}^2$ allows application of large sample volumes.

Although the SKAT is well-suited for the measurement of bulk textures on geological samples, restrictions are valid. Due to the pulse repetition rate of 5 Hz at the IBR–2 reactor, the maximum accessible lattice spacing d_{max} is restricted to about 4.9 Å. This may be sufficient for texture analyses even on three-phase samples (e.g., carbonate rocks consisting of calcite + dolomite + quartz). On the other hand, successful texture analysis may be hampered (e.g., in case of ultrabasic rocks or phyllosilicate-bearing gneisses).

Intended upgrading of the SKAT

Expansion of accessible d-range improves the possibilities for texture measurements. From Bragg's law,

$$\lambda = 2d \sin \Theta$$

and invariability of λ follows that expansion of d_{max} may be achieved by decrease of 2Θ only. We consider construction of a second detector system with $2\Theta = 65°$, keeping the old detector system for alternative use. Accessible d-range extends to about 6.5 Å, allowing access to more non-overlapped Bragg reflections. Inevitable deterioration of resolution $\Delta d/d$ by about 15–20% (compare to Fig. 1(b)) appears to be acceptable. In addition, the scanning possibilities will be improved by two more sample rotations around an horizontal and a vertical axis, respectively (Fig. 2). Thus, the recording of orientational data even for alternative methods of quantitative texture analysis (Bernstein et al. 2005) will be possible. Upgrading of the SKAT is scheduled contemporaneously with modernization of the IBR-2 reactor (2007–2009).

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Literatur

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