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EPSILON-MDS –a Device for intracrystalline Strain Measurements on Rocks at the pulsed Reactor IBR-2 in Dubna

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Due to its good penetration neutrons become a very suitable tool for texture and strain measurements of bulk samples. A high spectral resolution is required for materials of low crystal symmetry and/or if the sample consists of more then one phase. In general this holds for geological samples.

The diffractometer EPSILON-MDS is situated at the beam line 7A of the fast pulsed reactor IBR-2 in Dubna (Moscow region, Russia). The sample can be positioned with the aim of three translation stages ('x' and 'y' from 0 till 120 mm, 'z' from 0 till 50 mm) and a full circle rotation table. With a set of diaphragms both for the incident and for the diffracted beam any gauge volume can be realised, but due to the background smaller volumes than 5 x 5 x 5 mm^3should not be selected.

The neutrons, scattered by the sample, are guided through radial collimators to the detectors. Nine collimator-detector-blocks are fixed in a plane perpendicular to the incident beam, i.e. the neutrons are scattered with a constant BRAGG-angle $2\theta = 90^{\circ}$. Behind the exit windows of each collimator may be installed up to nine detector tubes. The collimator-detector-blocks are fastened on a ring carrier thus securing a constant second flight path (i. e. distance sample-detector). A single radial collimator consists of 48 mylar foils (10 μm thick), each foil coated with 40 μm GdO_2. The foils are inclined to each other with an angle of 20 angular minutes. The collimators have the shape of a frustum with an entrance window of about 50 x 50 mm^2 and an exit window of about 210 x 210 mm^2.

The detectors are ^{3}He-counters. The active length of the tubes is 120 mm. The axis of the tubes is parallel to a plane perpendicular to the incident beam and the scattered neutrons hit the detectors perpendicular to their axis. In order to avoid uncertainties for the length of the second flight path the diameter of the detector tubes was chosen to be sufficiently small (10 mm).

Strictly speaking, the BRAGG angle $2\theta = 90^\circ$ holds only for the central detector of each collimator block. The other detectors are situated at little different, larger or smaller scattering angles, respectively. Therefore, a detector set covers a region $82^\circ \leq 2\theta \leq 98^\circ$. Such a large 2θ-range will normally lead to a poor spectral resolution. This disadvantage is avoided by electronic time focussing, where the signals of each detector are treated with 'individual' width of the time channels when digitizing the time of flight of the neutrons. Additionally, the small differences of the second flight path are taken into consideration, which result from the arrangement of the detectors within a plane instead on the surface of a sphere.

The diffractometer EPSILON-MDS is equipped with a press for uniaxial load which permits to realize an applied load up to 100 kN, equivalent to 150 MPa for samples with standard sizes of 30 mm diameter and 60 mm length. The press is driven by a servo motor. The force, the velocity and quantity of deformation, as well as temperature are controlled. To stabilize the temperature conditions during our experiments, the whole diffractometer is housed in a cabin. Furthermore, it is planned to complete the measurement of strain-stress behaviour with the measurement of the velocity of p-waves or even with the detection of acoustic emissions during deformation experiments.