Bent-perfect-crystal (BPC) monochromator at the monochromatic focusing condition for residual strain diffractometer

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In conventional diffractometers with mosaic monochromators due to a nonnegligible $\lambda-\theta$ correlation of the monochromatic beam impinging the sample, the resolution considerably differs in the parallel (+,-) and anti-parallel (+,+) settings (see Fig. 1). However, a BPC monochromator at monochromatic focusing condition can provide equal resolution properties in both settings and gives a chance to use both sides of the scattering plane e.g. in the strain scanning. Then, if using both settings with the equivalent resolution, the measurement efficiency could be twice of that related to the traditional mode. Neglecting the blurring effect coming from the thickness of the curved slab and the width of the sample, in the case of the BPC-monochromator the angular resolution represented by $\Delta\alpha_2$ can be easily calculated according to $\Delta\alpha_2 = \Delta\alpha_1\left[2a_{SM}\left(1-L_{MS}/2f_M\right)-1\right]$, where L_{MS} is the monochromator-sample distance, $f_M=(R_M\cdot\sin\,\theta_M)/2$ is the focal length dependent on the radius of curvature R_M, θ_M is the Bragg angle and $a_{SM} = -\tan\theta_S / \tan\theta_M$ is the dispersive parameter having the opposite sign in the individual settings. Depending on the sign of a_{SM} we arrive at two parabolas representing the behaviour of $\Delta\alpha_2$ vs R_M (see Fig. 2). The intersection of the parabolas at $R_M=L_{MS}/\sin\,\theta_M$ corresponds to the monochromatic focusing condition, when all neutrons coming from the monochromator onto the sample have the same wavelength and the left-right asymmetry in $\lambda-\theta$ distribution in the scattering plane disappears. In this way we arrive at the same resolution $\Delta\alpha_2$ in the parallel and anti-parallel settings. It can be seen from the experimental data shown on Fig. 3 that in the vicinity of $R_M = 6$ m, $\Delta\alpha_2$ in both settings becomes equivalent. Then, similarly to the TOF technique, it makes possibility to measure two strain components, simultaneously.

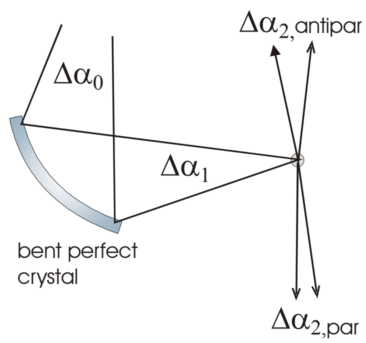

Figure 1: Sketch of a powder diffractometer in the so called parallel and anti-parallel settings.

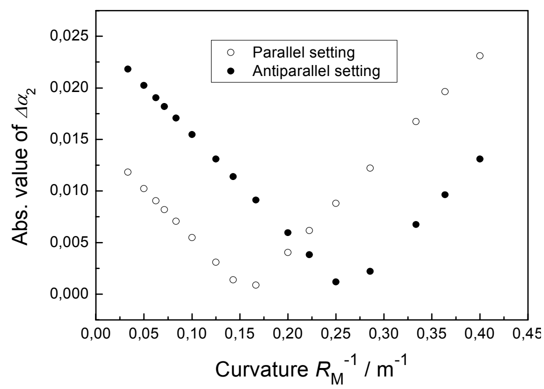

Figure 2: Divergence $\Delta\alpha_2$ vs crystal curvature for $\Delta\alpha_1=5\times10^{-3}$ rad, L_{MS}=2m, a_{SM}=2 and $\theta_M=25^o$.

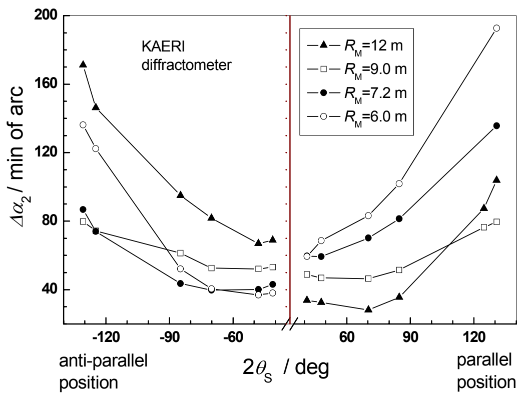

Figure 3: Results of $\Delta\alpha_2$-resolution for Si(220) BPC slab as a monochromator ($\theta_M=25^o$).

Neutron diffraction investigations are in this field partially supported by the projects AV0Z10480505, GACR 202/03/0891 and MSM2672244501.