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Bent crystal analyzer without grooves for inelastic scattering

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Analyzers for inelastic X-ray scattering spectroscopy provide good energy resolution (100-10 meV) at large angular acceptance by using spherically bent crystals in backscattering geometry. However, the energy resolution and reflectivity are affected by bending stress. This does not matter for analyzers around 7 keV with typical resolu-tion of 100 meV [1], but it becomes important for 10-meV analyzers (see [2] for a criterion). Cross-wise grooving of the crystals is used make their surface strain free [3].

In this paper we consider a way to avoid grooving. Instead of using normal incidence and a spherical bending, non-normal incidence (still with backscattering diffraction) and nonspherical bending are proposed. It is shown that the effect of strain upon the energy resolution and reflectivity can be canceled by compensating for the change in Bragg angle due to the d-spacing variations by a corresponding change in the orientation of the lattice planes of the deformed crystal.

A particular situation has been mentioned before [4] for spherically bent Si crystals. However, with spherical bending, the focal distances in the diffraction and the out-of diffraction planes are different due to the non-normal incidence. We propose to correct this by making the bending nonspherical.

Computations for several reflections of Si/Ge and photon energies are presented. The anisotropic properties of Si/Ge were taken into account when calculating deformations. The advantages and disadvantages of this method with respect to the grooved analyzer are discussed.

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