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Optimization of Highly Oriented Pyrolytic Graphite Crystals for Neutron Optics

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Abstract : The outstanding performance of highly oriented pyrolytic graphite (HOPG) as an optical element for neutron beam conditioning is unequaled by any other crystalline material in the applications of monochromator, analyzer, and filter. This superiority stems from the favorable nuclear properties of carbon (small absorption and incoherent scattering cross-sections, big coherent scattering length) and the specific crystalline structure (small thermal diffuse scattering cross-section, layered crystal structure). The real crystal defect structure revealed by imaging techniques is correlated with the parameters used in the mosaic model (mosaic spread, mosaic block size, uniformity). The diffraction properties (rocking curve width as determined by both the intrinsic mosaic spread and the diffraction process, peak and integrated reflectivity, filter transmission) as a function of neutron wavelength or energy can be predicted with high accuracy and reliability by diffraction theory using empirical primary extinction coefficients extracted from a great amount of existing experimental data. The results of these calculations are given as graphs and tables permitting to optimize HOPG characteristics (mosaic spread, thickness, curvature) for any given experimental situation.

Keywords : neutron optics, pyrolytic graphite, mosaic spread, neutron scattering, monochromator, analyzer
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