Detailed study of the neutron scattering from highly oriented pyrolytic graphite

Highly Oriented Pyrolytic graphite (PG) has a high Bragg reflectivity for neutrons and is therefore much used in instrumentation for monochromators and analyzers in all types of backscattering and triple-axis spectrometers.

PG can also be the source of background signals since it has low velocity phonon branches. If interpreted as Bragg scattering, these phonon branches will appear as broad spurious background signals. This has led to some backscattering instruments installing cooling to obtain better signal background ratio, but the need for cooling for triple axis types is disputed. Therefore it is important to quantify and understand scattering features from PG.

We here present an investigation of the total scattering features of PG at different temperatures. We used a diffractometer to obtain a two dimensional scattering map of a typical PG analyzer crystal. Intensities span 5 orders of magnitude and consist of Bragg diffraction, powder rings, phonon scattering and surprisingly also a signal that appears as specular reflectivity at high q.

From our investigations we present a model of all features in the data using McStas UNION, and a new general Born-von Karman phonon description for McStas, and a full instrument simulation model that can predict background features stemming from spurious scattering from PG analyzers. From our model we can effectively map scattering features as a function of both temperature and nominal analyzer energy, enabling study of PG effects on both backscattering and triple axis type instruments.

Our results show that while backscattering instruments do need cooling, triple axis instruments do not, due to a different orientation of the phonon scattering cloud. We argue that our McStas model will be useful to investigate scattering geometries of a wide range of instruments and determine possibilities of spurious signals and phonon contamination e.g. at novel multi analyzer instruments such as CAMEA, BIFROST and MUSHROOM.