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Nonmagnetic linear dichroism in fluorescence spectra of cubic solids

The determination of the absorption coefficient via transmission experiments is not always feasible. Common alternative methods for X-ray absorption spectroscopy (XAS) are the detection of electron and fluorescence yield (FY), implying that these are proportional to the absorption coefficient. This assumption is generally justified for the electron yield. The FY is influenced by saturation effects which can be reduced by choice of the experimental geometry. Furthermore the fluorescence process involves a twofold dipole transition, which implies that the FY is not only determined by the probability to absorb a photon, but also by the probability to emit a photon in the direction of the detector. The emission varies in direction and polarization, depending on the symmetry of the core hole and the states the core hole is filled from. In consequence even a saturation-free FY spectrum is generally not reflecting the X-ray absorption cross section. On the other hand, FY in a particular experimental geometry allows to probe the contribution of states of different symmetry selectively. Even in high-symmetry crystals, like cubic transition metal oxides, which exhibit no linear dichroism in XAS we observed dichroic effects in the fluorescence yield. In addition to paramagnetic MnO and CoO we examined antiferromagnetically ordered NiO in form of a bulk crystal as well as a crystal thin film. In the NiO thin film magnetic linear dichroism occurs in XAS originated by a preferred spin orientation due to a distortion of the cubic symmetry. We could distinguish the dichroic effects caused by the fluorescence process from magnetic linear dichroism in XAS. To explore the angle and polarization dependent fluorescence yield spectroscopy, we combined an experimental and theoretical investigation.

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