ATS Scattering from Isomorphic and Polymorphic Crystals

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The ATS scattering [1] is X-ray resonant scattering caused by the anisotropic terms of susceptibility. It can be observed in forbidden reflections near the absorption edge. It reveals the nature of empty electron-states of the atoms/ions in a crystal. We observed the scattering from pyrite structure, (FeS2, NiS2, CoS2), spinel structure (Fe3O4, ZnFe2O4, NiFe2O4), corundum structure (Fe2O3, Cr2O3), and polymorphic crystals of TiO2, rutil, anataze and brookite [2-5]. From experiments, we obtain following results. The scattering observed above the edges is caused by the dipole transition. The peaks in the pre-edge are caused by transitions through higher order terms. In the pyrite type, the energy spectra above the edges are similar to each other in spite of different ions. There are no peaks above the edges in a corundum type because the dipole transition is forbidden by the symmetry. In the pre-edge, hematite has a resonant peak, however eskolait has a peak with a shoulder. The peaks show three (hematite) and six-fold (eskolait) azimuthal dependence. They are explained by the quadrupole-dipole and the quadrupole transition. The ATS scattering in polymorphic crystals of TiO2 shows their own properties determined by the site symmetry of them. The energy spectra are different from each other though the absorption curves are similar.

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