C2 spectrometer demonstration

Magnetic phase transition in Haematite (Fe_2O_3)

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Haematite (Fe_2O_3) is a well known mineral that crystallizes in a rhombohedra corundum system, in which the oxygen ions are approximately close-packed and the cations occupy octahedral positions. Given the chemical composition, only two-thirds of the available octahedral sites are filled (Figure 1).

Haematite is a textbook example of canted antiferromangetism and exhibits a magnetic phase transition at TM=260K (Morin temperature) when the antiferomagnet spin ordering is reorganizing from being aligned perpendicular on the c axis to being aligned parallel to the c axis. Above the Morin temperature the spins are not perfectly anti-paralell and a slight canting leads to weak “parasitic” ferromagnetism. Bellow TM the spins are perfectly anti-parallel and the parasitic moment disappears (Figure 2).

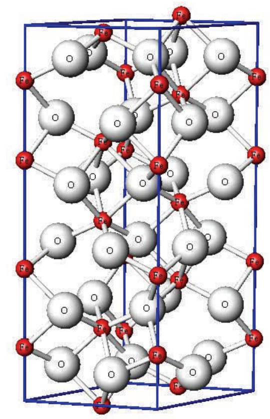

Figure1

In this demonstration:

The basics of a neutron powder diffractometer will be discussed, including the choice of spectrometer parameters to measure magnetic vs. nuclear reflections. Magnetic phase transition of haematite at TM=260K will be experimentally observed.

We will experimentally observe the magnetic phase transition in haematite by measuring the powder diffraction patterns at room temperature and below the Morin temperature.

We will also discuss, in general, the approaches used in analysis of a powder diffraction pattern, from pattern indexing and phase identification to crystal structure refinement by the Rietveld method.

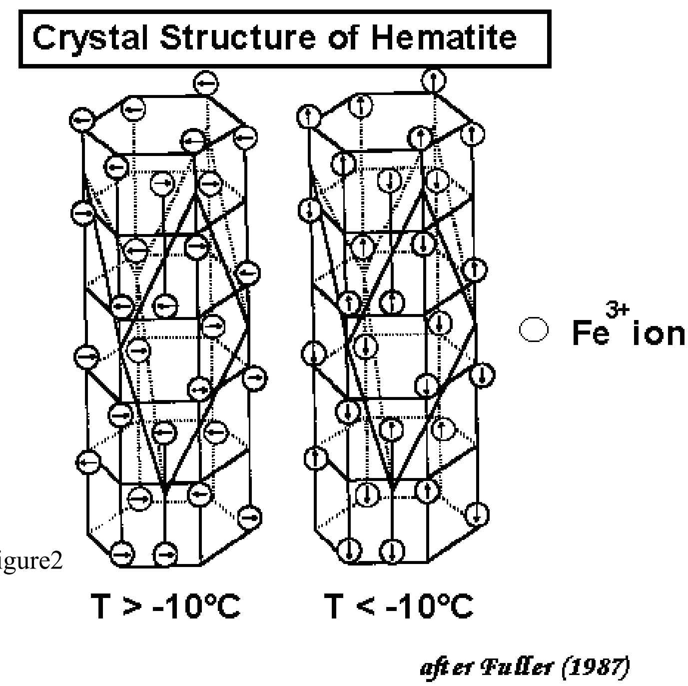

Figure2

Figure 3 shows the C2 powder diffractometer at NRU reactor. C2 is equipped with a curved 800-wire BF_3 position sensitive detector. The wire-spacing is 0.1°, so that 80° of scattering angle is measured simultaneously. The detector can be positioned in low- and high-angle settings to collect data from the complete 120° range of scattering angles. Within each setting it can be moved in steps as small as 0.01°.

Figure3