Contribution ID: 136 Type: Poster

Ferromagnetism of CrO2 under pressure studied using K-edge x-ray magnetic circular dichroism

Chromium K-edge x-ray magnetic circular dichroism (XMCD) from the half-metallic ferromagnet CrO_2 is found to be strongly suppressed by applied hydrostatic pressure such that dichroic signals at 15 GPa are less than half of their ambient values. Band structure and cluster calculations indicate that ~20% of this decrease is due to progressive quenching of the 4p orbital moment as the CrO_6 octahedra flatten under pressure. The majority of the XMCD reduction, however, is attributed to loss of magnetisation associated with a rapid lowering of the ferromagnetic ordering temperature, T_c . The decrease in T_c is found to be linear across the pressure range measured with a gradient of –4.74±0.9 K/GPa. Extrapolation of this trend gives a critical pressure for non-magnetism, PC = 45±11 GPa, that is less than the lowest P_c value of 65 GPa predicted by previous band structure calculations. It is argued that stronger antiferromagnetic superexchange interactions, associated with straightening of the Cr-O-Cr bond angle toward 180° under pressure may be responsible for the weakening of ferromagnetism. No change in the x-ray absorption pre-edge is observed as pressure is increased which is consistent with CrO2 remaining half-metallic up to at least 15 GPa.

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Session Classification: Poster Session B

Track Classification: Magnetic Surfaces, Interfaces and Nanostructures