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Investigation on the Nature of the Verwey Transition in Cu-doped Fe3O4

Magnetite (Fe3O4), the oldest known magnet, is still a hotly debated material in scientific research, due to its complex magnetic, electronic and transport properties. One of the most interesting physical phenomena associated with Fe3O4 is the occurrence of a metal-insulator transition at ~120 K (TV), the so-called Verwey transition, which is associated to a charge ordering below TV, accompanied with a structural transition from the cubic phase to the monoclinic phase. However, due to the twinning of crystal domain, the detailed crystallographic structure is not fully solved yet and different charge ordered and bond-dimerized ground states have been proposed. In order to overcome this problem, we have investigated Cu-doped Fe3O4 and have determined the stability range of the Verwey phase in the phase diagram of Fe1-xCuxFe2O4. Using neutron diffraction and high-resolution X-ray synchrotron diffraction we have investigate both the crystallographic and magnetic structure of Cu-doped Fe3O4 (CuxFe3−xO4 with x = 0 to 1.0) in order to elucidate the effect of doping on the Verwey transition. The obtained data indicate that the Verwey transition remains unchanged up to highest doping levels of 75% Cu-substitution. This large stability range of the Verwey phase is surprising and did require a systematic investigation. The analysis of our high-resolution diffraction data did allow us to extract detailed information on the precise doping mechanism, for example if the Cu-ions are placed on tetrahedral or octahedral sites in the spinel structure. The obtained data therefore provide valuable information on the charge order, i.e. the Verwey transition.

Topic

Physics

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