KINETICS OF THE VERWEY TRANSITION IN MAGNETITE

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The Verwey phase transition in magnetite at 124 K is mainly known due to the drop of resistance by two orders of magnitude while heating above the Verwey temperature T_V. Following the concept of Verwey [1] and Anderson [2], it was believed that strongly correlated electrons, one from each of two iron located at octahedral B-sites, travelling relatively freely between iron B cations, are responsible for the good conductivity at $T > T_V$. The abrupt increase in resistivity below T_V was explained as due to the localization of those interacting electrons at particular positions. The low-temperature order is described by formula: Fe^{3+} [$Fe^{(2.5+\delta)+}$ $Fe^{(2.5-\delta)+}$] O_4 where the square brackets mark the octahedral positions. The disproportionation value of $\delta_{12} = 0.12 \pm 0.025$ for one kind of Fe-atoms and $\delta_{34} = 0.1 \pm 0.06$ for another is confirmed by a resonant x-ray diffraction (RXD) [3]. This electronic charge ordering is related to the change in the structure symmetry, from high T cubic (*Fd-3m*) to monoclinic (*Cc*) for T below T_V. The results of recent investigations, however, suggest that there is decoupling between charge ordering and the lattice distortion [4].

To investigate the kinetics of the transition in details, two kinds of experiments has been performed. First, simultaneous measurements of the resistivity and the magnetic susceptibility while temperature maintained constant, were performed at the AGH Univ. of Sci. and Tech. in Krakow. The results are shown in Fig. 1.

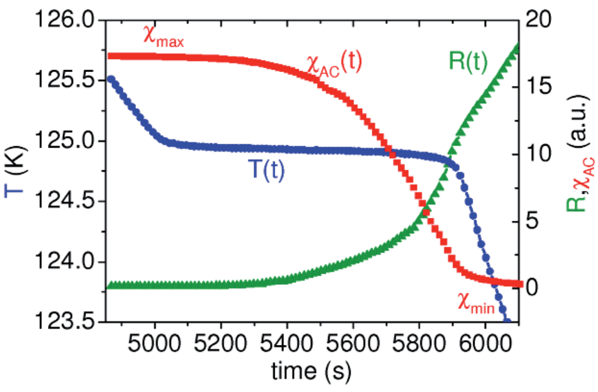

Figure 1. Temporal behavior of the resistivity $R(t)$ and the magnetic AC susceptibility $\chi_{AC}(t)$ measured simultaneously with the temperature $T(t)$ at the Verwey transition during sample cooling.

The second experiment has been performed at ESRF in Grenoble, ID10 beam line. The aim was to work out the processes related to the lattice distortion. For that we observed simultaneously the (1 1½ 2) superstructure peak intensity (absent in high-T cubic phase) and, for comparison with the previous experiment, the magnetic susceptibility. The results are shown in Fig. 2.

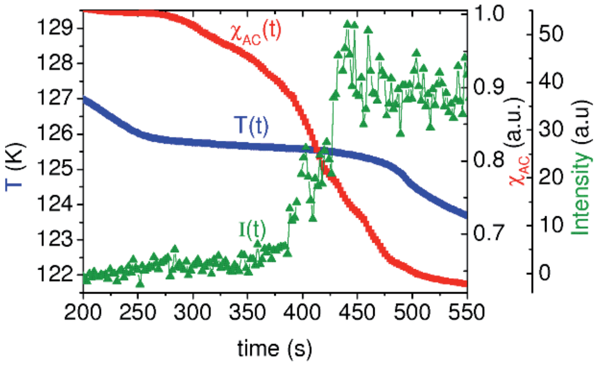

Figure 2. Temporal behavior of the integrated (1 3/2 2) superstructure peak intensity $I(t)$ and the magnetic AC susceptibility $\chi_{AC}(t)$ measured simultaneously with the temperature $T(t)$ at the Verwey transition.

We have traced all the ongoing processes, trying to see their temporal dependences and the subtleties of the transition. We note here that, although AC susceptibility is a magnetic parameter, it reflects booth the changing electronic system and the structure symmetry.

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