DOCTORAL THESIS

Zdeněk Švindrych

Low-field excitations in magnetite

Referee report by Pavel Novák

In the first chapter the present state of knowledge of magnetite below the Verwey transition is summarized, as well as possible methods of preparation of the magnetite samples and general description of experimental methods. I especially appreciated clear description of the magnetic susceptibility in sections 1.1.3 and 1.6.1.

The second chapter is more specific, dealing with methods and samples used to obtain the results described in thesis. The results obtained for the stoichiometric magnetite are summarized in chapter 3 and in chapter 4 the results for magnetite with cation vacancies are described. The main body of thesis ends with the discussion and brief conlusions.

At the Verwey transition the cubic symmetry of magnetite is lowered to the monoclinic one. As a consequence originally cubic crystal divides in 24 monoclinic structural domains. Coexisting with structural are the magnetic domains and at still lower temperature the ferroelectric domains come to existence. It is the interplay between these domains that lies in the heart of the effects studied in the thesis: 'glass-like transition' and 'low-temperature anomaly'. It is close to impossible to describe these effects on the microscopic level, but Zdeněk Švindrych succeeded remarkably well in explaining the underlying physics using semiempirical models.

Thesis are carefully and clearly written and I found only few typing and English errors. I have no remarks to the description of the experimental methods, several questions concerning the results and their interpretation are given below.

1/ The author writes about 'still not fully understood crystal and electronic structure of magnetite below the Verwey transition'. The situation changed last year, however, when the paper of Senn et al. appeared (Nature, 481, 173, 2012). Could the results of the Nature paper be used to shed some light on the problems discussed in thesis? I also note that there is little doubt about the existence of ferroelectricity and that it is compatible with the monoclinic Cc symmetry (see references in the Nature paper).

2/ Monoclinic domains influence the behavior of magnetite. I realize that the experimental setup prevents application of the strong magnetic field, which would suppress their number. Yet it is probably possible to modify their distribution by changing the cooling rate at the transition. Has the cooling rate any effect on the 'glass-like transition' or the 'low-temperature anomaly'?

The presented thesis fulfills the conditions for the PhD thesis and I have no doubt that Zdeněk Švindrych proved the ability to carry out successfully the scientific work. I suggest that after a successful defence of the thesis Zdeněk Švindrych will be granted the PhD title.

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