substance: Fe_3O_4
property: influence of substitution

substituted Fe_3O_4

^{18}O substitution shifts T_V to larger values; δT_V = 6.1(5) K for 43% ^{18}O substitution [79T].

F substitution causes T_V to decrease and the Verwey transition eventually to be suppressed [77W] (see Figs. 1, 2 for conductivity and Seebeck coefficient). Qualitatively similar but less marked effects are reported by [77C].
Ti substitution: Figs. 3...5. Energy gap in low temperature phase found to be 0.12 eV. Verwey transition is associated with an increase in the number of carriers rather than a sharp change in carrier mobility. The mobility has been found to be activated both below and above the transition temperature (Fig. 5).

Other transition metal substituents: Fig. 6, 7.

References:

57M Miles, P. A., Westphal, W. B., von Hippel, A.: Rev. Mod. Phys. 29 (1957) 279.
71C Constantin, C., Rosenberg, M.: Solid State Commun. 9 (1971) 675.
77C Claverie, J., Portier, T., Hagenmuller, P.: J. Phys. 38 (1977) C1-169.
77W Whall, T. E., Rigo, M. O., Jones, M. R. B., Pointon, A. J.: J. Phys. 38 (1977) C1-229.
79K Kuipers, A. J. M., Brabers, V. A. M.: Phys. Rev. B20 (1 979) 594.
79T Terukov, F. T., Reichelt, W., Ihle, D., Oppermann, H.: Phys. Status Solidi (b) 95 (1979) 491.

Fig. 1.

$Fe_3O_{4-x}F_x$. Conductivity of ceramics vs. reciprocal temperature. The arrows indicate the Verwey transition temperatures for x = 0 and 0.035 [77W].

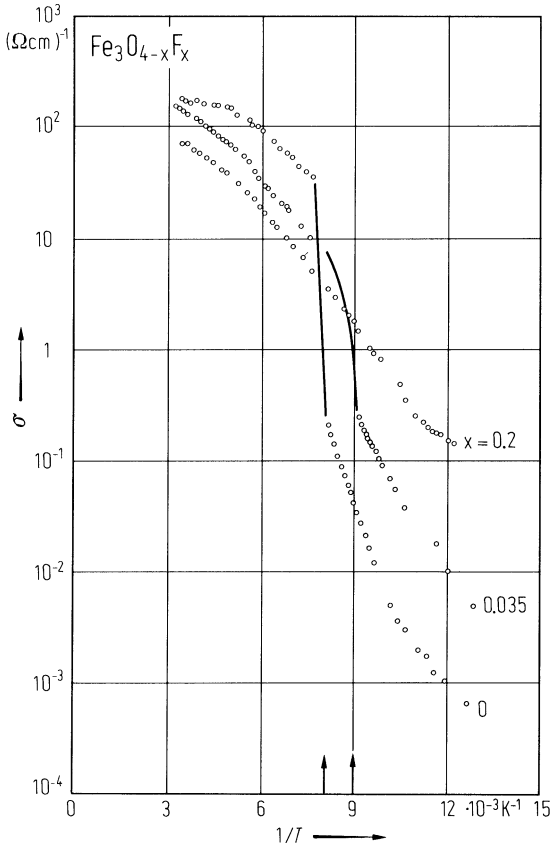

Fig. 2.

$Fe_3O_{4-x}F_x$. Seebeck coefficient vs. temperature for samples of different composition. The Verwey and ferromagnetic Curie temperatures are indicated for the x = 0 sample [77W].

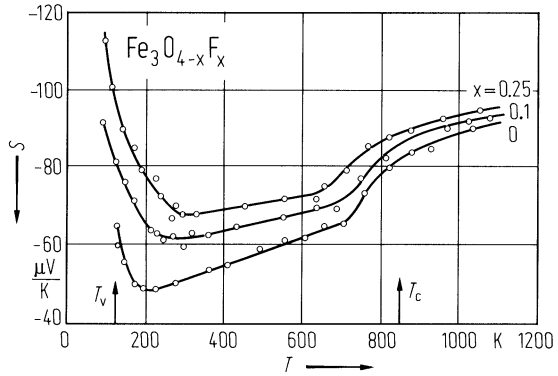

Fig. 3.

$Fe_{3-x}Ti_xO_4$. Conductivity ‖ [1 1 0] vs. reciprocal temperature for samples of different composition [79K].

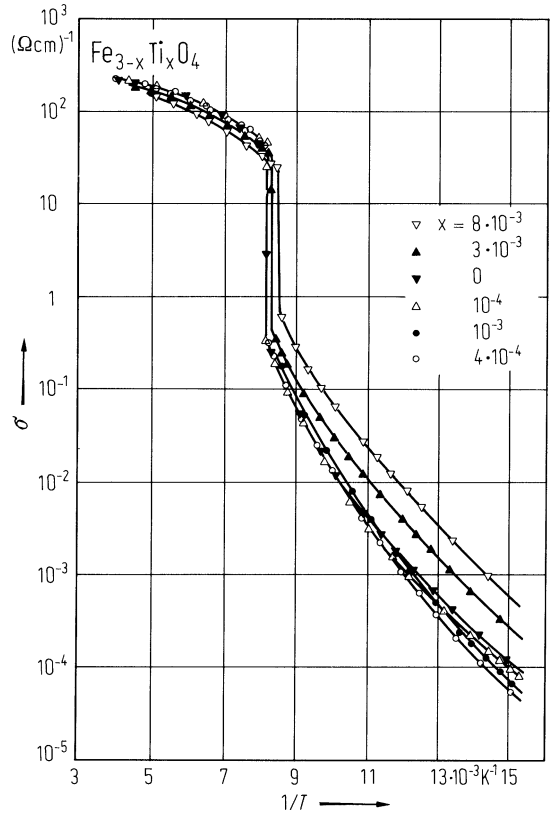

Fig. 4.

$Fe_{3-x}Ti_xO_4$. Seebeck coefficient vs. temperature for the samples of Fig. 3, measured ‖ [1 1 0] [79K].

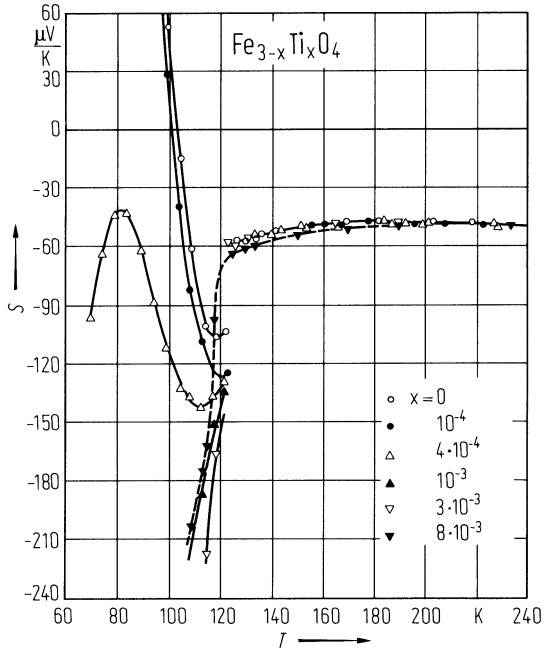

Fig. 5.

$Fe_{3-x}Ti_xO_4$. Conductivity along [110] vs. reciprocal temperature. The data points above T_V are experimental results for x = 0...10^{-3}. The curve labeled $ne\mu_n$ (where n is the concentration of electrons of magnetite i.e. the concentration of Fe^{2+}) is calculated from σ and S. No break at T_V is observed and this supports the hypothesis that μ_n is continuous over T_V [79K].

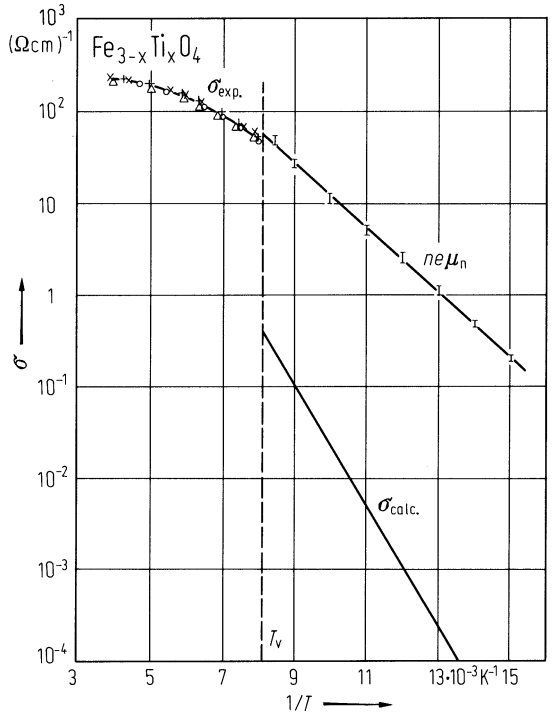

Fig. 6.

$Fe_{3-x}Mn_xO_4$, $Fe_{3-x}Co_xO_4$, $Fe_{3-x}Ni_xO_4$, $Fe_{3-x}Zn_xO_4$. Conductivity vs. reciprocal temperature [57M]. Orientation not specified.

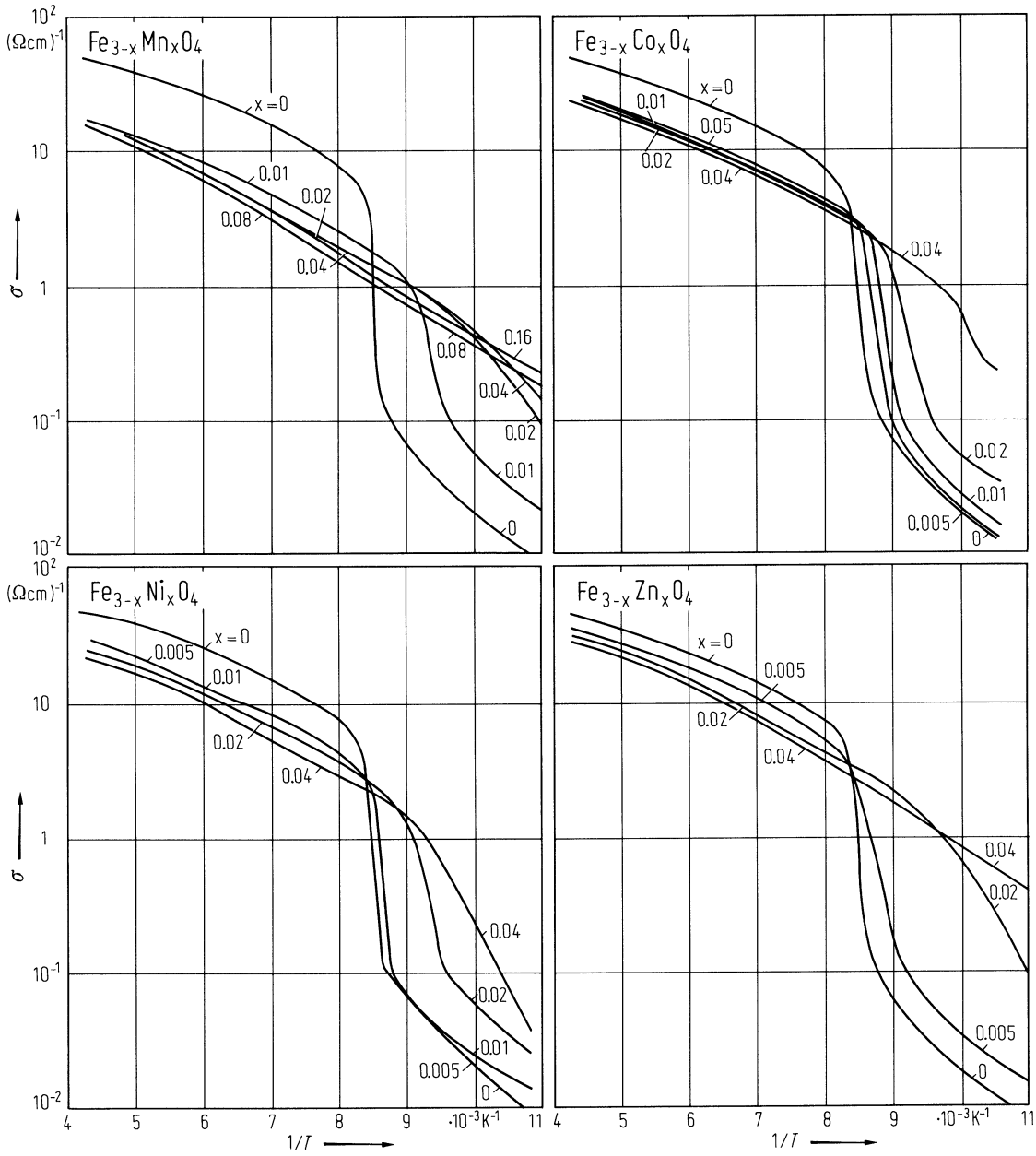

Fig. 7.

$Fe_{3-x}Mn_xO_4$, $Fe_{3-x}Co_xO_4$, $Fe_{3-x}Ni_xO_4$. Seebeck coefficient vs. reciprocal temperature [71C].