substance: Fe_3O_4
property: electrical conductivity

electrical conductivity: Figs. 1...3, 5. The Verwey transition is observed as a discontinuity in σ at 120(2) K [50D, 68S] and σ also shows a maximum at ≈ 300 K [57M], 360K [50D], and a further minimum at ≈ 780K [70G], 800 K [76P, 57M]. For the low-temperature phase some anisotropy in the conductivity is found, with the properties showing further strong dependence on magnetic field direction.

The conductivity minimum at high temperatures is correlated with the Curie temperature; it apparently represents a maximum in the spin-disorder scattering. The conductivity maximum at 300 K is associated with the onset of strong, dynamic electron-lattice interactions that correlate the mobile electrons [81S]

The Verwey transition decreases with increasing iron deficit, Fig. 2, a result supported by Moessbauer measurements [71W]. Below T_V, Fe_3O_4 behaves as a semiconductor, with an activation energy that decreases continuously with decreasing T. Alternatively, [71D] suggests that ln σ is linear with $T^{-1/4}$ from the Verwey temperature down to ≈ 10 K. Below this, the conductivity reaches a minimum of $10^{-15}\ \Omega^{-1}\ \mathrm{cm}^{-1}$ at 5.3 K and then increases [71D].

activation energy for conductivity

E_A	0.10 eV	T = 78...90 K	54C
	0.10(1) eV	T = 100...T_V	68S
	0.10 eV	T = 110 K	57M
	0.09 eV	T = 56...77 K	54C
	0.06 eV	T = 40...52 K	54C
	0.03 eV	T = 40 K	57M

stress and pressure dependence of transport parameters

stress dependence of conductivity: Fig. 4

d ln T_V/dp	$-4.0(2)\cdot10^{-3}$ kbar^{-1}		68S
dln E_A/dp	$-3.0(1.0)\cdot10^{-3}$ kbar^{-1}	$T \le T_V$	68S
dln ρ/dp	$-4.9(2)\cdot10^{-2}$ kbar^{-1}	T = 77 K	68S

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Fig. 1.

Fe_3O_4. Conductivity vs. reciprocal temperature (in the inset: vs. temperature) for stoichiometric single crystal material [57M].

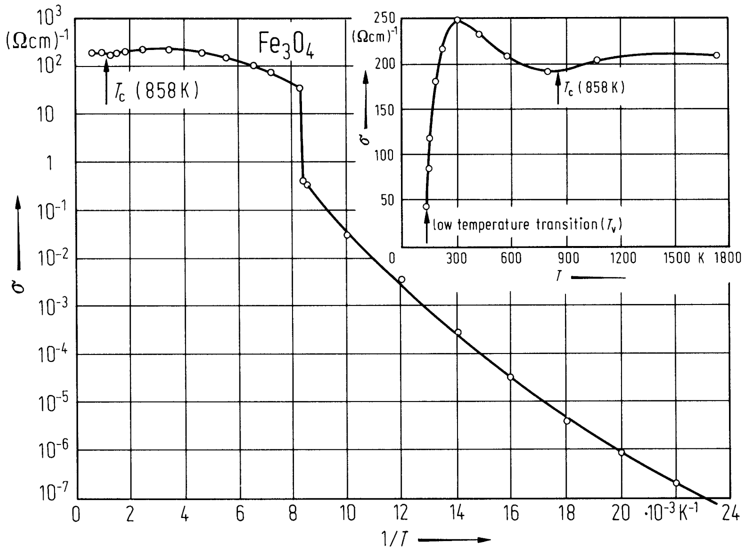

Fig. 2.

Fe_3O_4. Resistivity vs. (reciprocal) temperature for polycrystalline sample. The curves I to VI represent increasing Fe-deficit [41V].

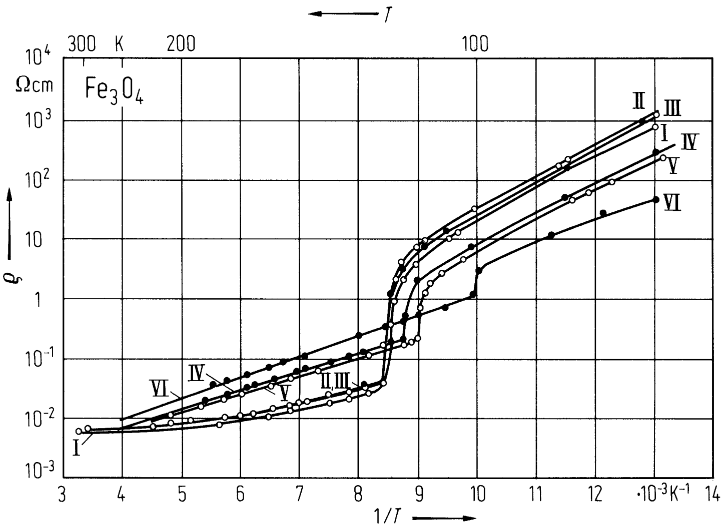

Fig. 3.

Fe_3O_4. Conductivity vs. (reciprocal) temperature. (a) anisotropy in the direction of the *1* $[1\bar{1}0]$, *2* [110], *3* [001] axes, (b) conductivity parallel to the [001] axis, while the direction of the magnetic field cooling is parallel to *1* [110] and *2* [001] + 40° [77M].

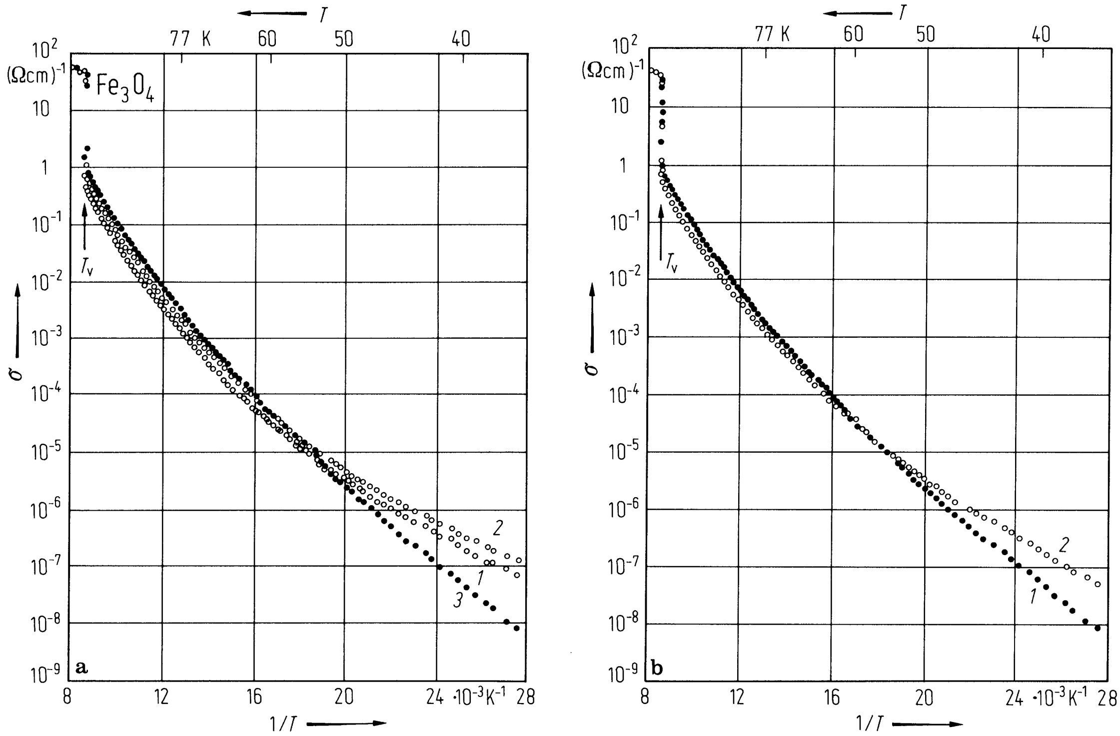

Fig. 4.

Fe_3O_4. Conductivity vs. (reciprocal) temperature in the $[\bar{1}11]$ direction for a squeezed and unsqueezed crystal (a), compared to the $[111]$ direction for an unsqueezed crystal (b); field cooled in (a) $[001]$ direction, (b) $[001]$ + 40° direction [77M].

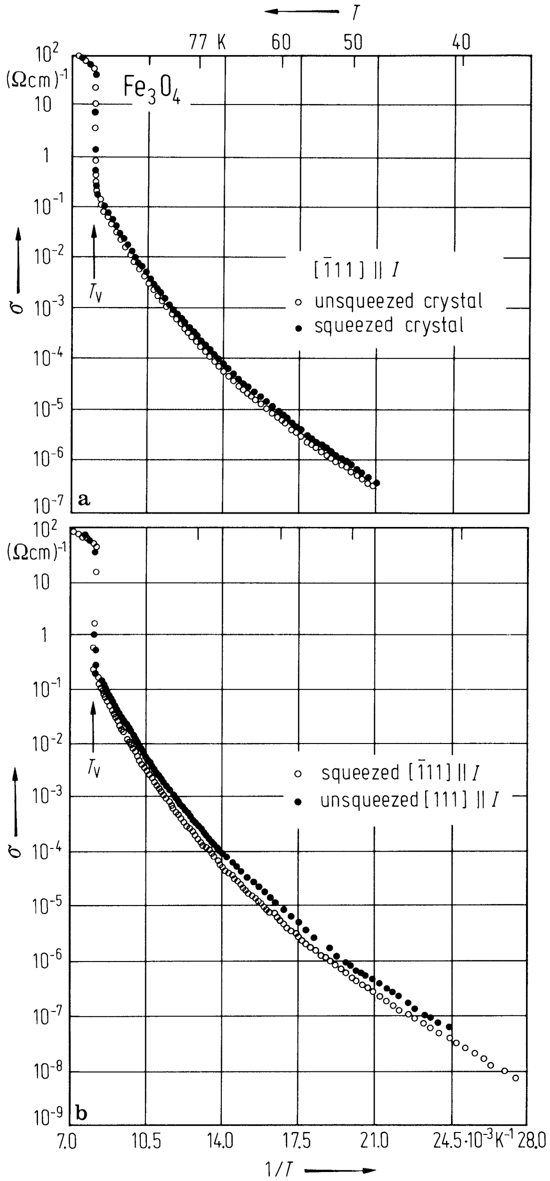

Fig. 5.

Fe_3O_4. Resistivity (full circles [70G], triangles [52S]) and Seebeck coefficient (open circles) vs. temperature at high temperatures ($T > T_V$) [70G].