MAGNETIC PROPERTIES OF $(Fe_{1-x} M_x)_7 Se_8$

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The temperature dependence of the magnetization of the quenched and slowly cooled samples of Fe_7Se_8 and $(Fe_{1-x} M_x)_7 Se_8$ samples with M = Co and Ni and x = 0.02, 0.05 and 0.08 were given. All the thermomagnetic curves obtained belong to the Weiss ferrimagnetic type. For some samples discontinuties indicating a magnetic transformation to antiferromagnetic order were obtained. The values of the magnetic moment μ_0 and $\mu_{7.8}$ were given. The temperature dependence of the reciprocal susceptibility in the paramagnetic range were studied and the asymptotic Curie points were given. The values of the effective magnetic moment μ_{eff} and the number of unpaired electrons were calculated.
The thermal variation of the electrical conductivity of the host material Fe_7Se_8 was given.

Introduction

The magnetic properities of the compounds formed between elements of the chalcogen group and the element of iron group are complicated. This would be attributed to the various possible distribution of the magnetic moments of cations (Fe) in the crystal/1,2/. Therefore it follows that a different magnetic coupling will occur by replacing cations by another kind of atoms of the same chemical group. The formation of phases with metal dificient NiAs-type structure/2/ is common to the binary systems of 3d- transition metals with the heavier chalcogen elements. NiSe is weakly paramagnetic/3/. CoSe shows a Curie-Weiss type magnetism/4/. Iron selenides exhibit both antiferromagnetic and ferrimagnetic behaviour depending on depending on composition and temperature/5,6/. Fe_3S_8 is the most highly magnetic and the most highly conducting for electricity of all other iron sulphides/7,8/. The fact that there are different types of magnetism in these alloys is not fully understood. The expected similarity between the ferrimagnetism of FeS_x and that of $FeSe_x$ encouraged us to study the magnetic properties of Fe_7Se_8 system when some iron atoms are replaced by cobalt and nickel atoms.

The nature of conduction carriers in the semiconducting compounds containing transition element which in most cases is not fully clear/9-11/.

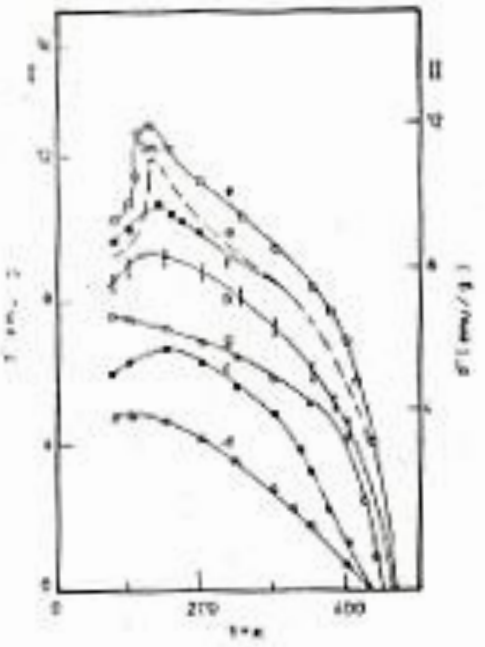

Fig (11). Magnetization-temperature dependence for quenched samples
(a) $Fe_{.7}Si_{.3}$ (b) M = 0.02 Ni (c) M = 0.05 Ni (d) M = 0.08 Ni
(e) M = 0.02 Co (f) M = 0.05 Co (g) M = 0.08 Co

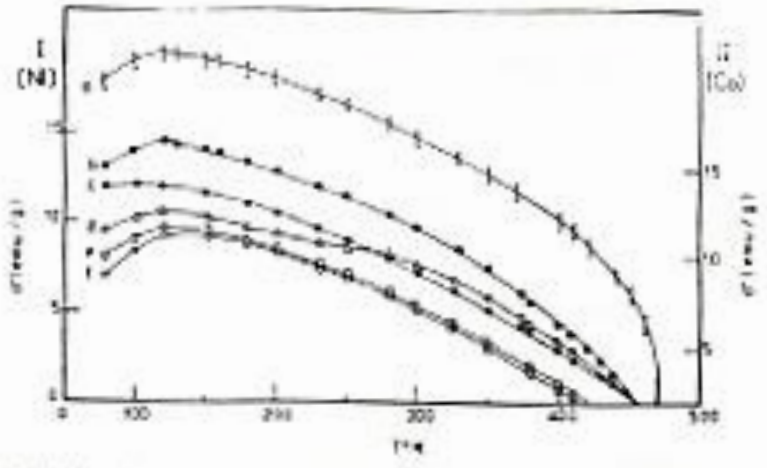

Fig (12). Magnetization-temperature dependence for slowly cooled samples
(a) M = 0.02 Ni (b) M = 0.05 Ni (c) M = 0.08 Ni
(d) M = 0.02 Co (e) M = 0.05 Co (f) M = 0.08 Co

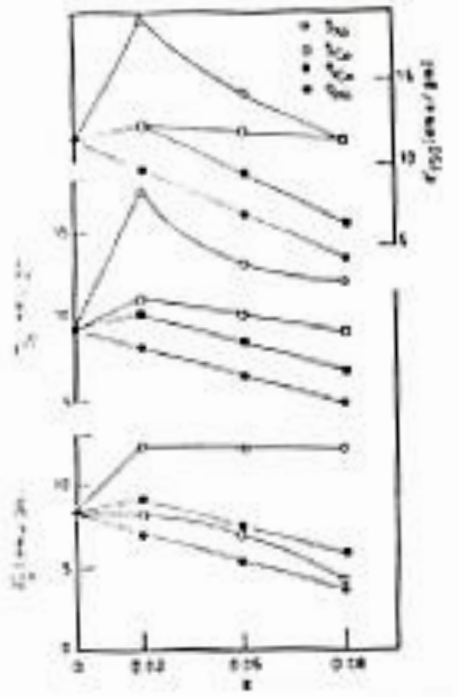

Fig (13). The magnetization vs. concentration of Ni and Co at 0, 78 and 150°K for the slowly cooled samples (S_{Co} and S_{Ni}) and the quenched samples (q_{Co} and q_{Ni}).

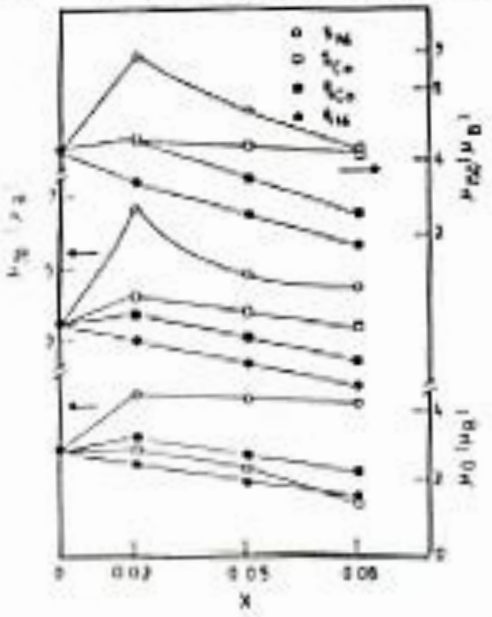

Fig (14). The variation of the magnetic moment in (μ_B) at 0, 78 ad 150°K (μ_0, μ_{78} and μ_{150}) with the concentration (x) in the $(Fe_{1-x}M_x)_2$ Se_3 samples

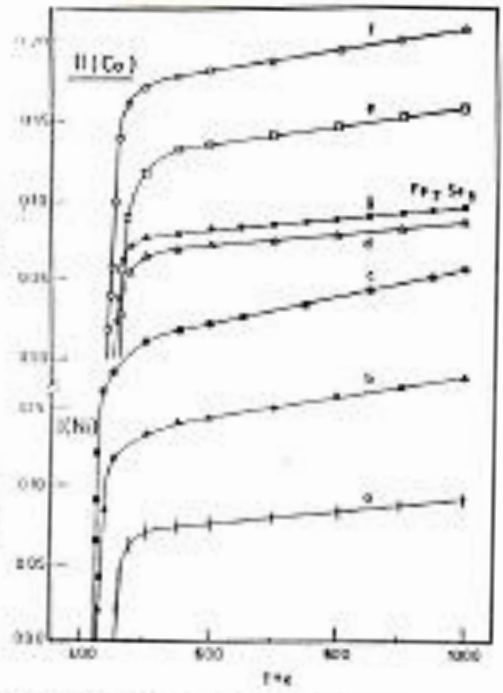

Fig (6). The dependence of the reciprocal susceptibility $1/\chi_m$ on temperature for the host material Fe_7Se_8 and $(Fe_{1-x}M_x)_7Se_8$ samples.

(a) M = 0.02 Ni (b) M = 0.05 Ni (c) M = 0.08 Ni (d) M = 0.02 Co
(e) M = 0.05 Co (f) M = 0.08 Co (g) Fe_7Se_8

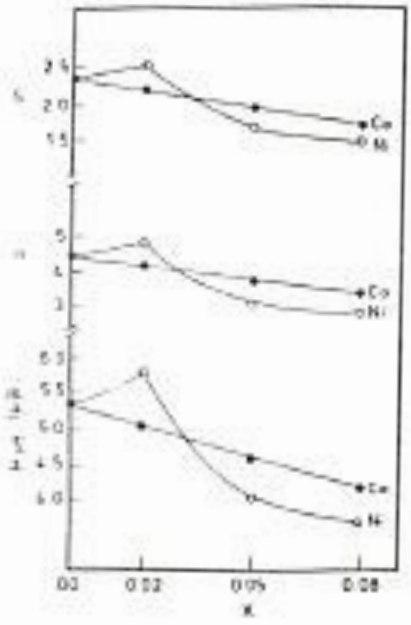

Fig (6). Dependence of the paramagnetic moment μ_{eff}, the spin quantum number S and the number of unpaired electrons n on the concentration in the paramagnetic $(Fe_{1-x}M_x)Se_8$ samples.

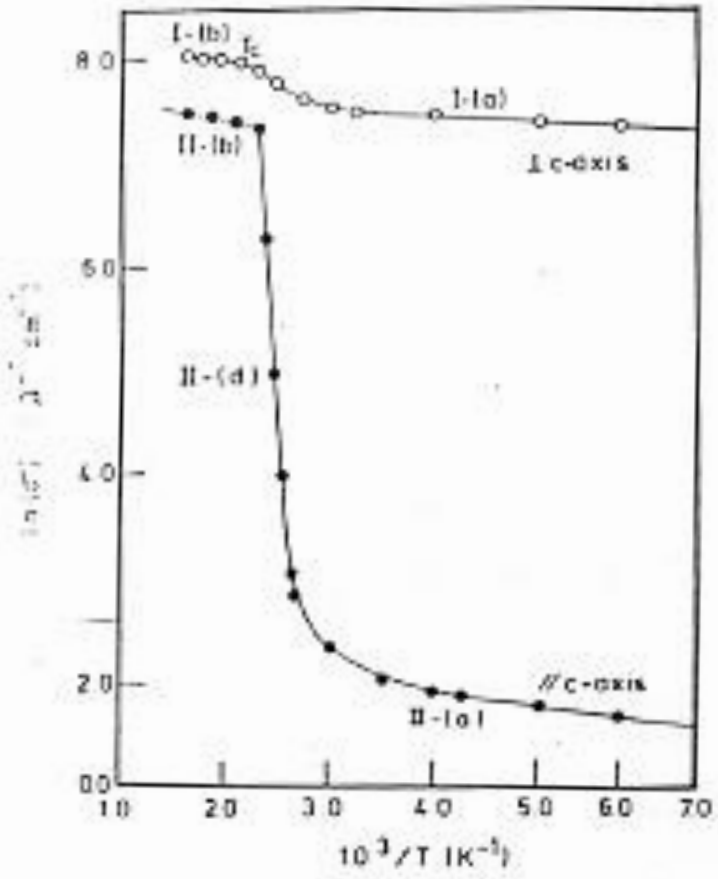

Fig (7). Thermal variation of the electrical conductivity ($\ln \bar{\sigma} - 1/T$) of the host material Fe_7Se_8 with the applied electric field

I. perpendicular to the c-axis

II. parallel to the c-axis.