ELECTRICAL RESISTIVITIES OF AMORPHOUS $(Fe_xNi_{100-x})_{.75}B_{.25}$ ALLOYS

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Accurate resistivity measurements were performed on several $(Fe_xNi_{100-x})_{.75}B_{.25}$ alloys in the temperature interval 1.5-450K. The overall resistivity behaviour is similar to that of amorphous $Fe_xNi_{80-x}B_{20}$ alloys and is dominated by the magnetic contribution to the resistivity.

Although the resistivities of number of amorphous ferromagnets were investigated earlier only recently has a qualitative understanding of the resistivity variation with temperature and Fe concentration been achieved in such alloys. A systematic study of $Fe_xNi_{80-x}P_{14}B_6$ and $Fe_xNi_{80-x}B_{20}$ alloys[1,2] indicated that in these alloys the resistivity variation (above the minimum) is dominated by the magnetic contribution to the electron scattering. Here we present preliminary measurements on $(Fe_xNi_{100-x})_{.75}B_{.25}$ system which also support that view. This system was selected in order to study the effect of increasing the metalloid (B) content and/or of the chemical short range order in stoichiometric amorphous alloys.

At low temperatures ($T < 30K$) all our alloys have a resistance minimum below which the resistivity increases with decreasing temperature. This is illustrated in the insert to Fig.1 for three alloys and a more detailed account of the low temperature resistivities of our alloys will be given elsewhere[3]. We note that the origin of the resistance minimum in metallic glasses is still not clear and that there is not any agreement as to which (magnetic or structural) interaction is responsible for the minimum. Without entering into details of this problem we note that the slopes of the resistivity below the minimum depend somewhat on Fe content (x) and that the highest slope appear for x=50 as in amorphous $Fe_xNi_{80-x}B_{20}$ alloys.

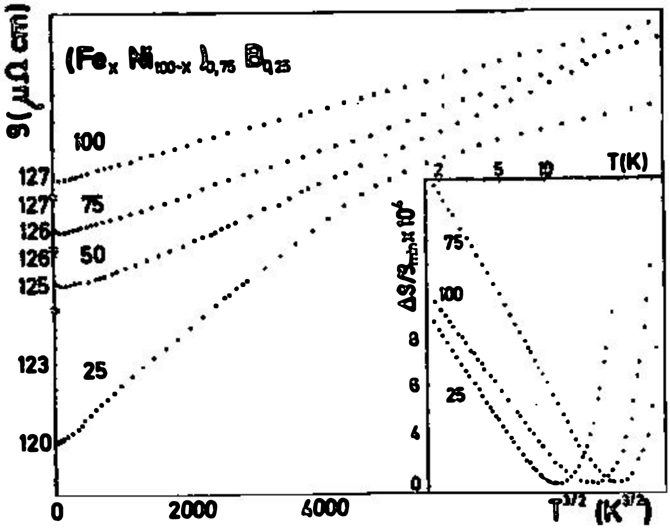

Fig.1. The resistivities above the minimum of four $(Fe_xNi_{100-x})_{.75}B_{.25}$ alloys vs $T^{3/2}$. In the insert the low temperature resistivities of three alloys from the same system. The numbers denote x.

The resistivity above the minimum increases approximately as $T^{3/2}$ as illustrated in Fig.1. A strong concentration dependance of this variation indicates its magnetic origin. The coefficient of the $T^{3/2}$ term (A) shows a rapid initial decrease with increasing Fe content. Since the alloys with the lowest Fe content (x) have also the lowest Curie temperatures (T_c) it is very probable that this term is mainly caused by electron-magnon scattering which is stronger in those alloys with lower Curie temperatures and lower spinwave stiffnes constants. At higher Fe concentrations ($x > 50$) the Curie temperatures of our alloys tend to saturation and the x dependance becomes less pronounced.

Indeed a dominant $T^{3/2}$ resistivity contribution was predicted for the amorphous ferromagnets[5,6] well below T_c. In these calculations a $T^{3/2}$ term was ascribed to the incoherent electron-magnon scattering. It is interesting to note that in our alloys this contribution remains dominant to a sizeable fraction of T_c ($\approx$0.3). However the magnetization of amorphous ferromagnets[2] shows the same temperature dependence in approximately the same temperature interval.

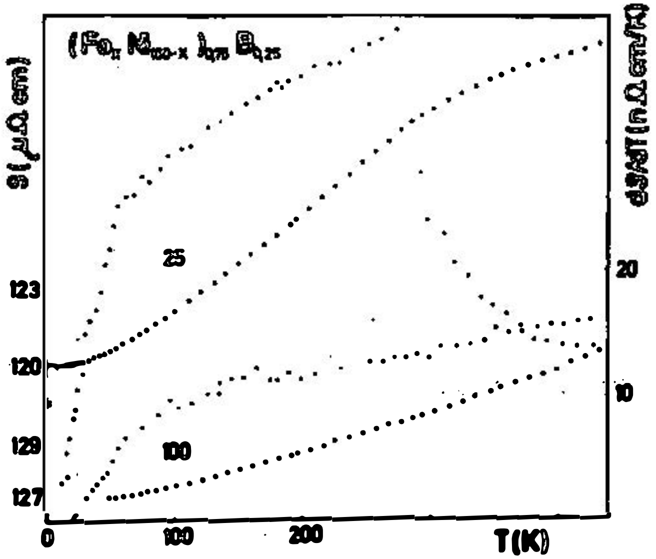

Fig.2. The resistivities ϱ and temperature derivatives $d\varrho/dT$ of the resistivity of two $(Fe_xNi_{100-x})_{.75}B_{.25}$ alloys vs temperature. The numbers denote x.

At higher temperatures ($0.3T_c < T < T_c$) the resistivity of $(Fe_xNi_{100-x})_{.75}B_{.25}$ alloys can be rather well represented by the contribution of linear and T^2 terms. This is illustrated in Fig.2 where the resistivities andtemperature derivatives of the resistivity for two alloys are shown. The coefficients B and C of a linear and T^2 term respectively again decrease with increasing x and therefore seem to be also dominated by the magnetic effects. In this temperature interval the mean field approximation is expected to give adequate description of the resistivity of ferromagnetic alloys. For $T \ll T_c$ the theoretical resistivity dependence (Brillouin function) can be rather well described by the combination of linear and T^2 term. Furthermore in crystalline $Au_{1-x}Fe_x$ alloys[7] which form another class of inhomogenous ferromagnets M(0)-M(T) also obeys a law of the form $aT+bT^2$ with coefficients decreasing with M(0) and x. Unfortunately the magnetization of our alloys have not been measured so that a more quantitative discussion of our data is not yet possible. Nevertheless our results indicate that in both, spin-wave region and at higher temperatures (but below T_c) the magnetic contribution to the resistivity (which depends essentially on the spontaneous magnetization) dominated the overall resistivity variation. Finally we note that around the Curie temperature the critical behaviour dominates as illustrated by the temperature derivative of the resistivity of $(Fe_{25}Ni_{75})_{.75}B_{.25}$ alloy shown in Fig.2.

The comparison of the data for $Fe_xNi_{80-x}B_{20}$[1] and $(Fe_xNi_{100-x})_{.75}B_{.25}$ alloys shows that for a given Fe-Ni ratio the relative change in resistivity above the minimum is somewhat smaller in the latter system. This may be either due to change in the structure factor (nonmagnetic part) or due to a decrease in magnetization. The measurements of both, structure factors and magnetization are requred to elucidate this question.

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