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MAGNETIC PROPERTIES OF A QUASI-BINARY $U(Fe_{50}Mn_{50})_2$ Alloy*

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The ac magnetic susceptibility of a quasi-binary $U(Fe_{50}Mn_{50})_2$ alloy was measured between 4.2 and 290 K. The obtained results are analysed according to the Fermi liquid model of magnetism. It is shown that the appearence of the broad maximum of the susceptibility at about 135 K can be attributed to the $T^2 \ln T$ dependence of $\chi(T)$.

МАГНИТНЫЕ СВОЙСТВА КВАЗИДВУХКОМПОНЕНТНОГО СПЛАВА $U(Fe_{50}Mn_{50})_2$

В работе приведены результаты измерений переменной магнитной восприимичивости квазидвухкомпонентного сплава $U(Fe_{50}Mn_{50})_2$ в интервале температур 4,2 – 290 K. Приведен анализ полученных данных, исходя из модели Ферми жидкости магнетизма. Показано, что существование широкого максимума восприимчивости в окрестности точки 135 K может бытъ приписано зависимости $\chi(T)$ от температуры вида $T^2 \ln T$.

I. INTRODUCTION

Uranium forms cubic Laves Phases (C 15 type structure) with iron and manganese. UFe_2 is ferromagnetic with Curie temperature in the range from 130 to 190 K [1, 2, 3]. This range of Curie temperatures reflects variation in the stoichiometry od UFe_2 compounds [3, 4]. UMn_2 is only weakly magnetic, although conflicting reports exist for its detailed behaviour [5, 6, 7]. In the present paper we report on the magnetic susceptibility measurements of the quasi-binary $U(Fe_{50}Mn_{50})_2$ alloy as a function of temperature.

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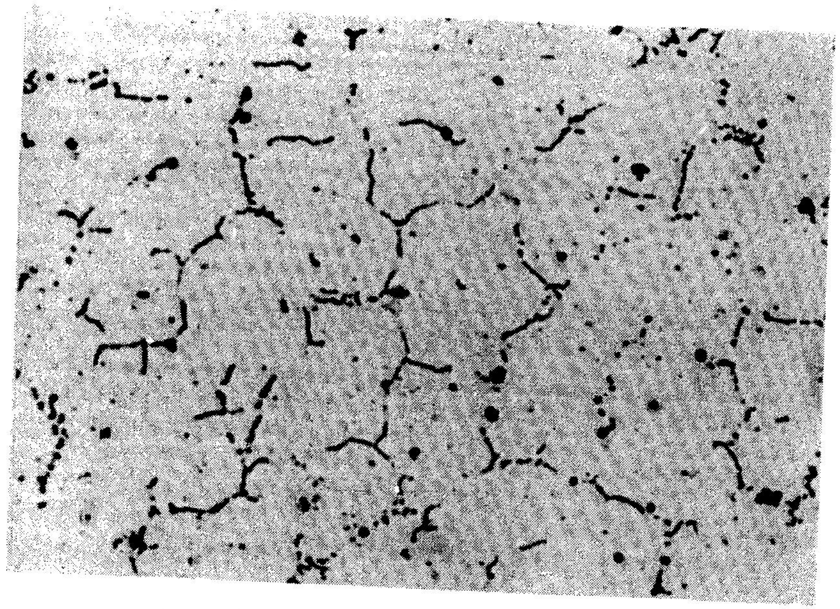

Fig. 1. Micrograph of the $U(Fe_{50}Mn_{50})_2$ compound (×400).

II. EXPERIMENTAL

The $U(Fe_{50}Mn_{50})_2$ samples were prepared by a crucible-less, semi levitation, induction melting in an argon protective atmosphere. The purity of uranium was 99.98 % and that of the 3rd elements 99.99 %. The sample cubic Laves phase structure was confirmed by X-ray analyses. Metallographic examination showed the presence of a small amount (<6 vol %) of a parasitic phase in the form of intergranular networks (Fig. 1).

The magnetic susceptibility measurements were performed on powdered samples using an ac mutual inductance bridge of the Hartshorn type. The intensity of the alternating field used was 160 A/m.

III. RESULTS AND DISCUSSION

The temperature dependence of the magnetic susceptibility was investigated in the temperature range from 4.2 to 290 K. The observed course of $\chi(T)$ is shown in Figure 2. It can be seen that an apparent broad maximum appears in $\chi(T)$ at about 135 K. The explanation of the occurence of a such maximum has been given by S. Misawa [8] in the Fermi liquid model of magnetism. If one regards a system of

strongly correlating electrons as a Fermi liquid, the temperature dependence of the susceptibility is shown to be given by the expression

$$\chi(T) = a - bT^2 \ln (T/T^*), \quad (1)$$

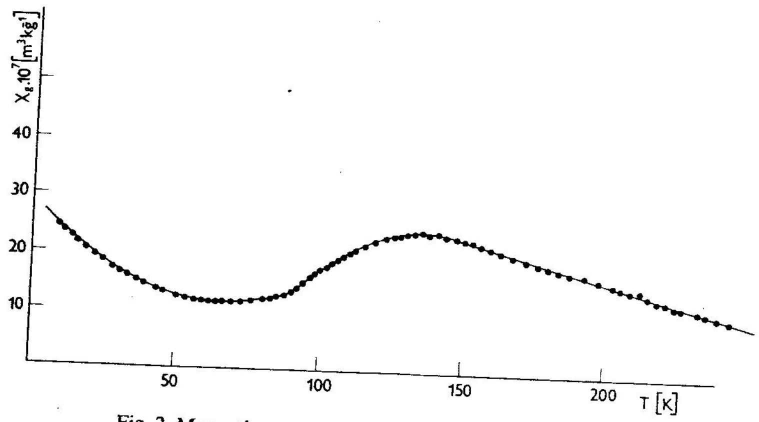

Fig. 2. Magnetic suscepttibility as a function of temperature.

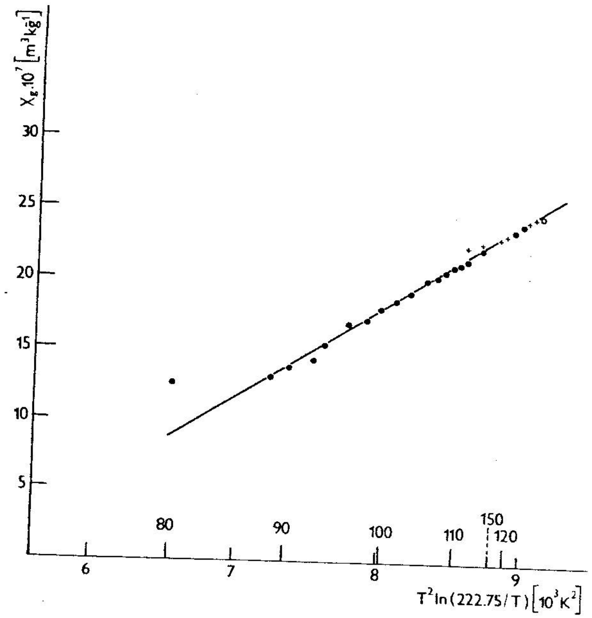

Fig. 3. Magnetic susceptibility of the $U(Fe_{50}Mn_{50})_2$ compound plotted as a function of $T^2 \ln (222.75/T)$. Solid circles and crosses denote respectively the experimental points below and above $T_{max} = 135$ K.

where a, b and T^* are constants ($b > 0$). This relation predicts the existence of a maximum in $\chi(T)$ at a temperature $T_{max} = \sqrt{e}T^*$. In our case (Fig. 2) the maximum is seen to occur at $T_{max} = 135$ K and hence $T^* = \sqrt{e}\, T_{max} = 222.75$ K. By plotting the observed susceptibility as a function of $T^2 \ln (T^*/T)$ one sees that a linear relation is clearly established in the range $90 < T < 160$ K (Fig. 3). The sharp rise of $\chi(T)$ below 40 K can possibly be explained by the onset of a ferromagnetic order. Above 160 K the higher order terms such as $T^4 \ln T$ probably become important.

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