ON MAGNETIC PROPERTIES OF UGaFe

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The X-ray diffraction and the temperature dependence of AC susceptibility and magnetization were measured on UGaFe. The results of investigation of two samples indicate a strong influence of stoichiometry and/or dependence on the rate of intermediate phases.

О МАГНИТНЫХ СВОЙСТВАХ UGaFe

В работе приведены результаты измерений диффракции рентгеновских лучей и температурной зависимости переменной составляющей магнитной восприимчивости и намагниченности в UGaFe. Результаты изучения двух образцов обнаруживают сильное влияние стехиометрии и зависимость от скорости образования промежуточных фаз.

I. INTRODUCTION

In recent studies [1, 2] the compounds UGaNi and UGaCo were found to be magnetically ordered below 41 and 51 K, respectively. In the futher course of investigation our interest centred upon the similar compound UGaFe. In paper [3] among others also the physical properties of UGaFe were studied by Mössbauer spectroscopy. Upon this occasion it was found that in the system UFe_2—UGa_2 in dependence on the content of individual components there occur intermediate phases with the structure of the type of $MgZn_2$, Mg_2Cu_3Si and Fe_2P. According to [3] at 4.2 K the ^{57}Fe spectrum of the stoichiometric compound U_2Fe_3Ga broadened. Attributing the broadening to magnetic ordering this corresponds to a magnetic moment 0.3 μ_B on iron atoms.

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II. TECHNOLOGY

The sample was prepared by melting weighted amounts of individual components corresponding to the composition of UGaFe in an arc furnace with a He protective atmosphere. The sample was then homogenized one week at the temperature 1300 K. The procedure was the same as that in the preparation of single phase samples UGaNi and UGaCo (Fe_2P type) [1, 2].

III. RESULTS

On the X-ray diffraction pattern of our sample (proposed composition UGaFe) shown in Fig. 1 it was possible to identify the diffraction lines of the structure of the Fe_2P type ($a = 0.6729$ nm, $c = 0.78$ nm — these parameters are near to those given

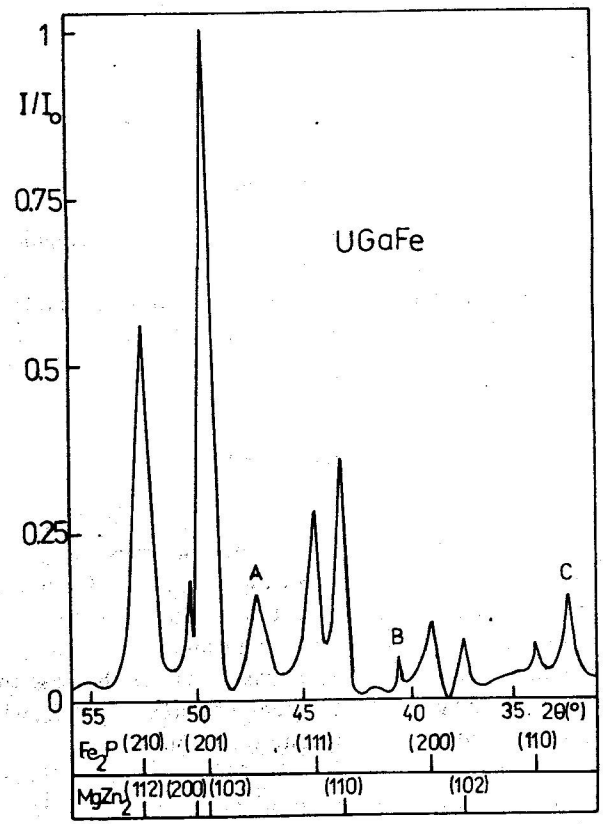

Fig. 1. X-ray diffraction patterns of UGaFe

in [4]), further the lines corresponding to the structure of the $MgZn_2$ type ($a = 0.527$ nm, $c = 0.81$ nm) and the lines A, B, C which could not be identified unambiguously.

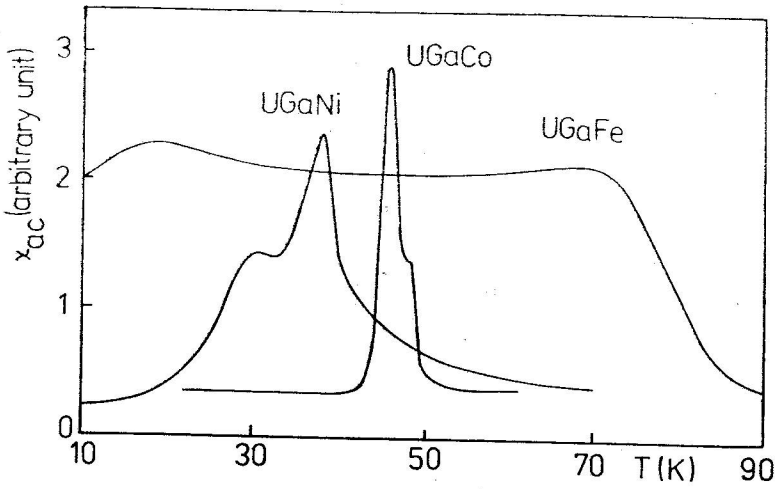

Fig. 2. Temperature dependence of AC susceptibilities of UGaNi, UGaCo and UGaFe

In Fig. 2 there are shown the results of the temperature dependence of the AC susceptibility of spherical samples to three UGaX compounds in a low field (5×10^{-2} mT, 230 Hz). According to [5] the temperature dependence of the DC susceptibility of our UGaFe sample can be described by the relation $\chi = \chi_0 + C(T - \Theta_p)^{-1}$ and the following values were found: $\chi_0 = 5.1 \times 10^{-8}\ m^3 kg^{-1}$, $C = 4 \times 10^{-6}\ K^{-1} m^3 kg^{-1}$ and $\Theta_p = 73.6$ K.

IV. DISCUSSION

Sharp peaks are seen on the $\chi_{ac}(T)$ curves for UGaNi and UGaCo, which is in accordance with the single phase character of these samples (see [1, 2]). The broad maximum on the $\chi_{ac}(T)$ curve observed for the sample of UGaFe (Fig. 3) may be due to its complicated phase structure. But an analogous shape of $\chi_{ac}(T)$ curves with flat characteristics were also found for instance in $Eu_xSr_{1-x}S$ compounds, which contain magnetic clusters and a spin glass phase. In this case two maxima in $\chi_{ac}(T)$ develop corresponding to transition temperatures T_f and T_c, which shift with small increasing static fields in the opposite directions [6].

According to the X-ray analysis the sample of UGaFe contained besides the Fe_2P type about 20 vol. % other phases. Evidently, for futher investigation the complicated technological problem of preparing a single phase sample must be resolved. The deviations from stoichiometry can also play a significant role. In

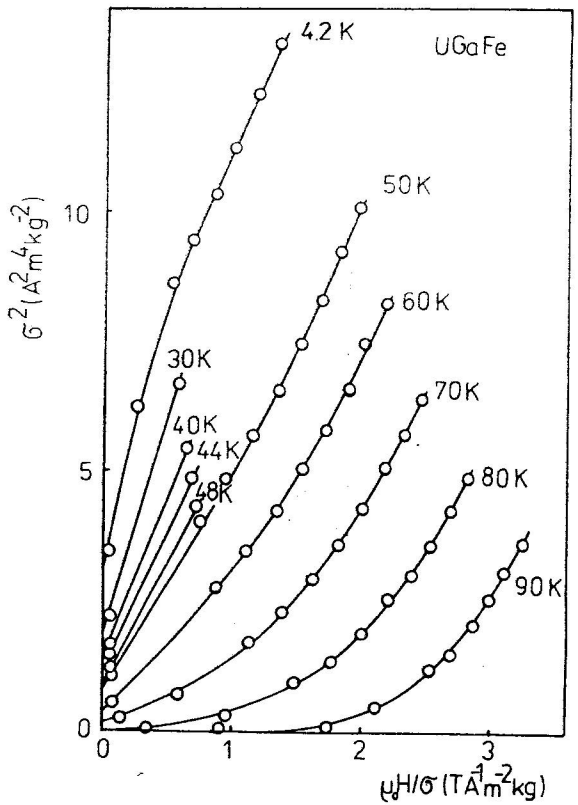

Fig. 3. Arrot plots of UGaFe

Fig. 3 there are shown Arrot plots which speak in favour of the magnetic ordering in our sample of UGaFe. In this case, at 4.2 K the value $\sigma \approx 3\ Am^2 kg^{-1}$ was obtained in the field of 2.2 T [5]. A new sample of UGaFe prepared with the greatest care was not single phase, neither of the Fe_2P nor the $MgZn_2$ type and, moreover, it had a negligible magnetic moment in the temperature range of up to 4.2 K and in fields up to 2.2 T (the value measured by means of the vibrating magnetometer was $\sigma \ll 0.2\ Am^2 kg^{-1}$). Thus it seems that in the case of the UGaFe compound the magnetic properties are significantly governed by deviations from the stoichiometry of the composition in the same way as in UFe_2 [7] and/or by the topological disorder as in intermetallic compounds of Group VIII with Group IIIA elements, which contain special antistructure atom defects that have a remarkable influence upon their magnetic parameters [8].

V. CONCLUSIONS

Two polycrystalline samples of UGaFe were prepared and their X-ray and magnetic phenomena were investigated. From the results a strong dependence of the magnetic properties of UGaFe on the stoichiometry and on the content of intermediate phases can be deduced.

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