HEAT CAPACITY AND THERMODYNAMIC PROPERTIES OF $TlCoS_2$

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This paper deals with the investigation of the heat capacity of the ferromagnetic compound $TlCoS_2$ in the temperature interval 55-300K. It is shown that behavior of the magnetic part of the heat capacity of $TlCoS_2$ is characteristic of for quasi -low -dimensional magnets. There have been calculated thermodynamic parameters of changes of $TlCoS_2$ entropy and enthalpy on the temperature dependence of the heat capacity.

In paper [1] there have been synthesized and investigated some physical properties: structure, magnetization and paramagnetic susceptibility of $TlCoS_2$ compound. It is shown that $TlCoS_2$ crystallizes as the hexagonal structure ($c/a \approx 6$) and is the low-dimensional ferromagnetic with the Curie temperature 112K. Study of influence of space and spin anisotropy on the behavior of the magnetic heat capacity, and also on the behavior of the phase junction in the ordered state is of great interest.

In this paper we measure heat capacity of $TlCoS_2$ compound in the temperature interval 55-300K and calculate main thermodynamic parameters (change of entropy, enthalpy). Heat capacity is measured by the adiabatic method [2]. By measurement of the heat capacity there have been used samples, which were synthesized and studied in work [1].

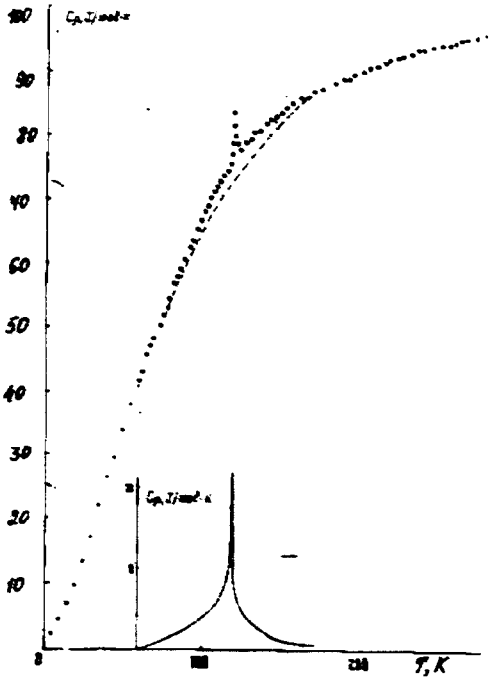

Fig.1. Temperature dependence of the heat capacity of TeCoS2: • - experimental points, × - calculated, — - lattice and ___ - magneto – parts of the heat capacity.

In fig.1 the temperature dependence of $TlCoS_2$ heat capacity is shown. As it is seen in the dependence $C_p(T)$ pronounced λ- anomaly has not been obseved. In the region of 118K there have been observed the minor anomaly, which apparently is connected with the magnetic junction. It was impossible to determine critical parameters of the magnetic phase junction because of the small anomaly. Temperature, corresponding to this anomaly is close to the temperature of the three-dimensional junction defined from the magnetization in work [1].

To isolate a magnetic contribution to a heat capacity of a magnetically ordered substance, as a rule one can choose such a nonmagnetic reference compound whose heat capacity and its temperature dependence are close to the lattice contribution to the heat capacity of an investigated magnetic substance. We could not find an isostructural diamagnetic compound for magnetic heat capacity liberation because of the deficiency of necessary data. Therefore we used $TlCrS_2$ compound, having the like structure with $TlCoS_2$. Temperature dependence of $TlCrS_2$ lattice heat capacity is described by V.V. Tarasova formula [3] with the Debye temperature θ_2 =342K and θ_3 =103K (data on $TlCrS_2$ heat capacity is in the press). We note, that in spite of Tarasov's model simplicity it is used for description of the lattice heat capacity of laminated and chain magnetic compounds with less number of adjustable parameters in the region $C_{lat} >> C_{mag}$. We used the method of corresponding states [4] with r =1.022 for calculation of C_{lat} of $TlCoS_2$ as compared with $TlCrS_2$. Obtained lattice (broken line) and magnetic (solid line) heat capacity ($C_{mag}=C_{ex}- C_{cal}$) of $TlCoS_2$ are presented in fig. 1. As it is seen, the magnetic heat capacity has wide maximum at $T_{c\ max}$=118K and approaches to zero above ~ 180K. The presence of wide maximum with high-temperature line on the curve $C_{mag}(T)$ above T_c is the characteristic feature of the magnetic $TlCoS_2$ heat capacity. Such behavior of the heat capacity is characteristic of quasi-two-dimensional systems. Below ~180K the compound $TlCoS_2$ apparently passes to the three- dimensional magnetic ordering connected with to distant orders, i.e. $TlCoS_2$ becomes the to three- dimensional magnetic. There have been observed the contribution of the close order to the heat capacity at higher temperature.

Magnetic energy and entropy, calculated with integration C_{mag} and C_{mag}/T are equal to ΔH_{mag}= 154.6 J/mol, ΔS_{mag}= 1.41 J/mol·K, respectively.

In paper [1] by investigation of magnetic properties and based on the laminated structure authors come to the conclusion that $TlCoS_2$ is the low- dimensional magnetic with the ferromagnetic ordering. Magnetic susceptibility of low- dimensional magnetics also has specific displays different from three - dimensional systems. Dependence $\chi(T)$ is described by Curie-Weis law in the range of high temperatures. With the decrease of the temperature $\chi(T)$ has the wide maximum connected with formation of the close order [5]. However such behavior of the susceptibility is not

observed for $TlCoS_2$ [1]. We note that using the Gudenaf model based on competition between direct cation-cation and indirect cation-anion exchanges, authors of paper [6] tried to explain the two-dimensional ferromagnetic behavior of the ordering in $TlCrS_2$. Complete structural data are necessary for application of the similar explanation in case of $TlCoS_2$.

On the base of the temperature dependence of the heat capacity there have been calculated thermodynamic functions (change of entropy and enthalpy of $TlCoS_2$) in the range 0-300K. Below ~ 55Kthe value $C_p(T)$ was calculated on the Debay law. Then the value of the Debay temperature was found on the experimental value of the temperature at ~ 60K.

Table presents values of $TlCoS_2$ entropy and enthalpy change.

T. K	50	100	150	200	250	300
S_T-S_0, *J molK*	28.82	62.58	94.88	120.0	140.6	157.9
H_T-H_0, *J mol*	0.748	3.354	7.240	11.60	16.23	21.01

[1] *R.Z.Sadikhov, E.M.Kerimova, Y.G. Asadov, R.K. Veliev.* FTT, 2000, V. 42, №8, pp. 1449-1450.

[2] *M.A. Aldjanov, N.G. Guseinov, G.D. Sultanov, M.D.Najafzade.* Phys. Stat. Sol. (b) 1990, v. 159, №2, p.107-110.

[3] *V.V. Tarasov.* Problems of glass physics. Moscow, Gosstroyizdat, 1979, p. 256.

[4] *R. Chisholm, J. Stout.* J. Chem. Phys., 1962, v.36, №2, pp. 972-979.

[5] *M. Steiner, J. Villain, C.G. Windsor.* Adv. Phys., 1976, v.25, №2, pp. 87-209.

[6] *M. Rosenberg, W. Knille.* J. Phys. Chem. Sol., 1982, v.43, №2, pp.87-95.

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$TlCoS_2$ -NİN İSTİLİK TUTUMU VƏ TERMODİNAMİK XASSƏLƏRİ

İşdə 55-300 intervalında $TlCoS_2$ ferromaqnit birləşməsinin istilik tutumu tədqiq edilmişdir. Göstərilmişdir ki, $TlCoS_2$-nin maqnit istilik tutumu kvaziaşağı ölçülü maqnetiklərə xas olan gedişə malikdir. İstilik tutumunun gedişinə əsasən $TlCoS_2$-nin termodinamik parametrləri entropiya və entalpiya hesablanmışdır.

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ТЕПЛОЕМКОСТЬ И ТЕРМОДИНАМИЧЕСКИЕ СВОЙСТВА $TlCoS_2$

В работе исследована теплоемкость ферромагнитного соединения $TlCoS_2$ в интервале 55-300K. Показано, что поведение магнитной части теплоемкости $TlCoS_2$ характерно для квазинизкомерных магнетиков. На температурной зависимости теплоемкости вычислены термодинамические параметры изменения энтропии и энтальпии $TlCoS_2$.

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