MAGNETIC PROPERTIES OF THE INTERMETALLIC COMPOUNDS TiNi UNDER UNIAXIAL PRESSURE

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Reversible structural phase transformation (PT) in intermetallic compound TiNi from high-temperature (HT) volume-centered cubic phase (austenite with B2 CsCl type lattice) to low-temperature (LT) rhombic phase B19 with additional monoclinic distortion (martensite) provides [1] superelasticity and "shape memory" effect [2].

At the room temperature the homogeneity region spreads between 50.5–51.5 at.% of Ni. The deviation from stoichiometric composition to the side of Ti surplus or Ni surplus leads to appearance of Ti_2Ni or $TiNi_3$ phases, respectively [3].

Measurements of magnetic susceptibility (MS) is a very effective method of PT and impurity electronic state investigations [4]. So it was of great interest to study MS of titanium nickelide obtained by powder metallurgy method as important object for technical applications [5].

TiNi samples were prepared by compacting and following annealing at 1420 K during one hour. The MS was investigated by relative Faraday method with the help of electronic balances with automatical compensation in the temperature range of 4.2–450 K [4].

The typical MS-temperature dependence of TiNi annealed sample is shown on the Fig. 1 (curve *1*). MS is paramagnetic within the whole investigated temperature range. In the PT region the MS-temperature dependence describes the hysteresis loop. Plateau is observed of the temperatures which are lower and higher than PT temperature region. The PT causes the MS change $\Delta\chi$ of about 28%.

MS of TiNi is a sum of the following basic constituents:

$$\chi = \chi_{dia} + \chi_p + \chi_{vv},$$

where χ_{dia} is a precessional diamagnetism of Langewen; χ_p is a free electron paramagnetism of Pauli; χ_{vv} is a polarization paramagnetism of Van Vleck. It depends upon the symmetry of ions electronic core and consequently on the character of chemical bond.

We suppose that there are two reasons of the MS increase due to PT:

1) the increase of the density of states on the Fermi level which leads to increase of Pauli paramagnetism;

2) the crystal lattice softening at temperatures higher than Debaye temperature with the formation of defects which lead to local distortions of crystal lattice and consequently to the increase of Van Vleck paramagnetism.

It is known that PT in TiNi may occur under external mechanical loading at fixed temperature. On Fig. 1 we can see the MS-temperature dependence of the same sample TiNi exposed to uniaxial pressure of 80 and 320 MPa (curves *2* and *3*, respectively). As a result, the temperature independent sample paramagnetism increased. It must be noticed the decrease of MS magnitude change during martensite transformation $\Delta\chi$ for deformed sample in comparison with the initial value: it is 19 %, and 6 %, respectively.

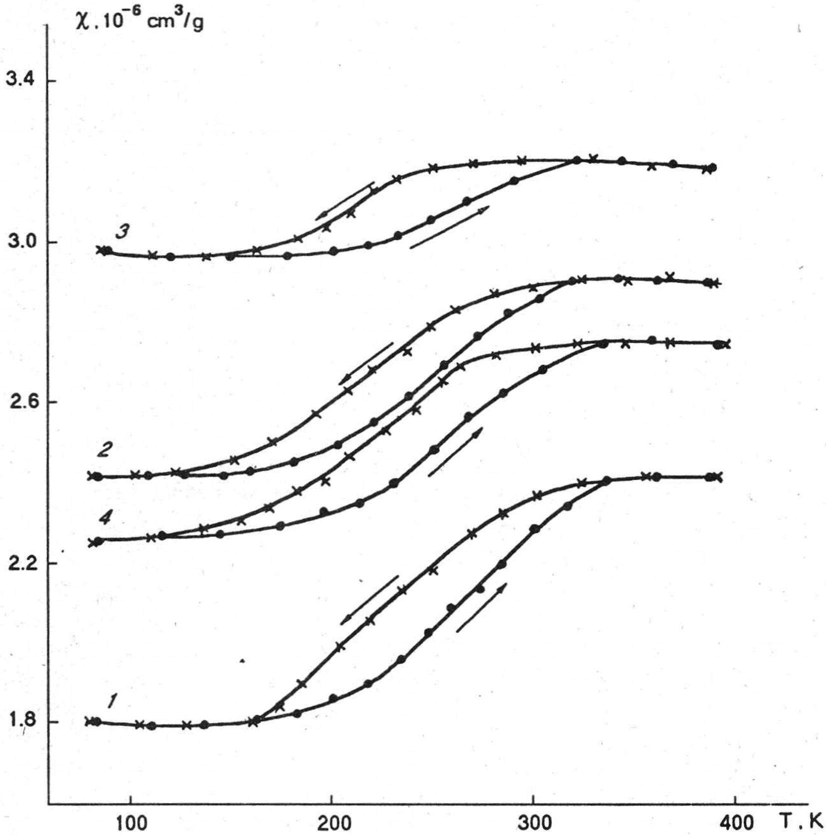


Fig. 1. MS vs temperature dependence for sintered sample of TiNi: initial sample — *1*; after uniaxial compression — *2* (80 MPa), *3* (320 MPa); after the second sintering — *4*

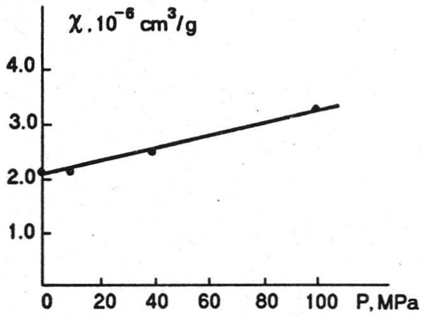
The obtained results can be explained by the formation of stable low-temperature phase (SLT), which does not transform to cubic phase up to 450 K and has more larger density of states on the Fermi level than in the case of LP and HP. The decrease of $\Delta\chi$ with deformation increase have shown that the part of sample volume occupied with SLP increases with deformation.

The sample annealing at 1420 K during half an hour leads to MS decrease in the whole temperature range but it does not reach its value for initial sample (curve 4). A compacting of TiNi powder without following annealing of formed samples also leads to austenite HP MS increasing linearly under pressure (Fig. 2).

We discovered a similar paramagnetism increase for deformed bulk TiNi samples also (Fig. 3) MS of the sintered TiNi. The hysteresis loop is not observed in the investigated temperature range because it moves in the direction of high temperatures. Thus MS dependence on deformation can be observed both in the case of powder and sintered material.

The investigations of the molybdenum powder compacted samples showed the absence of influence of deformation on MS in this case.

So, the observed new phenomena — dependence of MS on pressure is a peculiarity of the material which has a PT and is not stable in respect of changing the



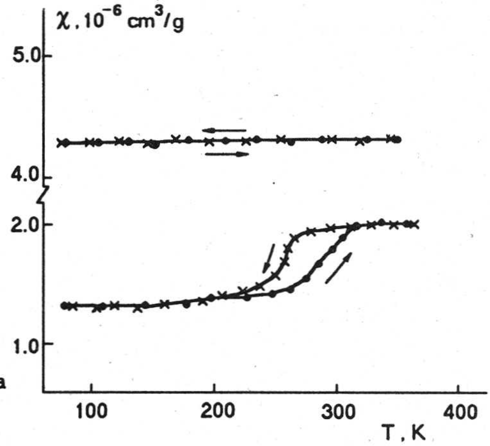


Fig. 2. MS dependence for initial TiNi powder in the austenitic state on pressure

Fig. 3. MS vs temperature dependence for sintered TiNi sample

phase composition under external action. MS shows special sensibility to the change of material phase composition. Therefore MS is an extraordinary productive method for investigations of such kind.

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