Magnetostriction Of Charge Density Wave Superconductor

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Abstract. Single crystals of layered niobium diselenide (2*H*-$NbSe_2$) compound with hexagonally packed layers were studied in a range of temperature 1.5 -300 K by measuring magnetostricrtion and magnetization in field up to 20 T. The data are compared with magnetic susceptibility measurements. Specific features of measured temperature and field dependences were observed near CDW transition temperature (32.5 K) and superconducting transition (7.2 K), sensitive to magnetic field direction and strength.

Keywords: magnetostriction, magnetic susceptibiliry, phase transition.
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INTRODUCTION

Notwithstanding the broad diversity of measurements performed on the CDW superconductor 2*H*-$NbSe_2$, some important issues are still unclear. Among them there is the behavior of magnetic properties in the vicinity of low temperature phase transitions in a magnetic field. Early studies and the following investigations of magnetic susceptibility [1-4] in the vicinity of CDW transition gave the contradictory results. Here we make attempt to elucidate some aspects of the problem.

RESULTS AND DISCUSSION

The niobium diselenide (2*H*-$NbSe_2$) is well studied superconductor, characterized by the layered crystal structure and moderately anisotropic (uniaxial) superconducting properties (T_{SN}=7.3 K). Its properties near the CDW transition (32.5 K) are less studied. The magnetostriction measurements complemented by magnetization data, appeared to be the effective tool for studying the magnetic behavior of 2*H*-$NbSe_2$ under destruction of superconductivity by magnetic field [5]. They have revealed identical behavior of strain and magnetization change with magnetic field in the singled out regions that is of the peak-effect regime and quantum oscillations. Here the similar effort is focused on the region of transition to the CDW state in 2*H*-$NbSe_2$. The high-quality single crystals of 2*H*-$NbSe_2$ compound were studied here in the temperature range 1.5-300 K by means of the magnetostriction and magnetic susceptibility measuring techniques. Magnetostriction was registered by means of the capacitance bridge in magnetic field up to 20 T applied in plane and in hexagonal axis direction. Parallel (in-plane) and perpendicular components of magnetic susceptibility were measured by Faraday technique in field 0.83 T and the parallel component was measured by SQUID magnetometer in field 300 Gs. Figures 1 and 2 present the low temperature measurements of magnetostriction and magnetic susceptibility. The peculiarity of the magnetic properties measured in high enough magnetic field is clearly seen both for magnetostriction and magnetic susceptibility measurements. The low field measurements in SQUID magnetometer did not reveal such a peculiarity. The quality of the crystals and different geometries of experiment exclude explanation of the observations by the experimental errors. The discrepancy of measurements can be explained by different values and direction of the external magnetic field strengths.

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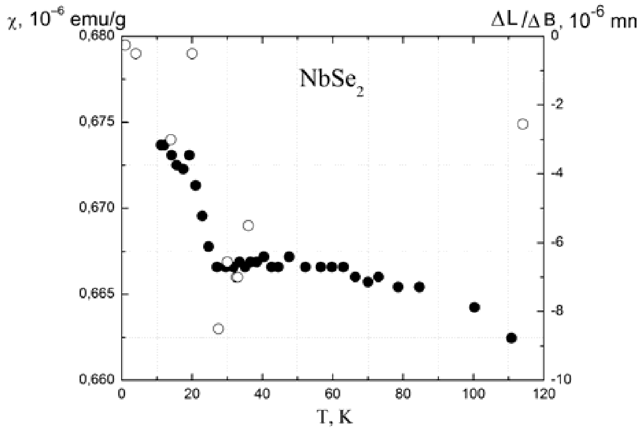

FIGURE 1. Magnetic susceptibility (filled circles) and magnetostriction (empty circles) of 2*H*-$NbSe_2$ single crystal measured in magnetic field parallel to the *ab* plane of the strength 0.83 and 20 T, respectively.

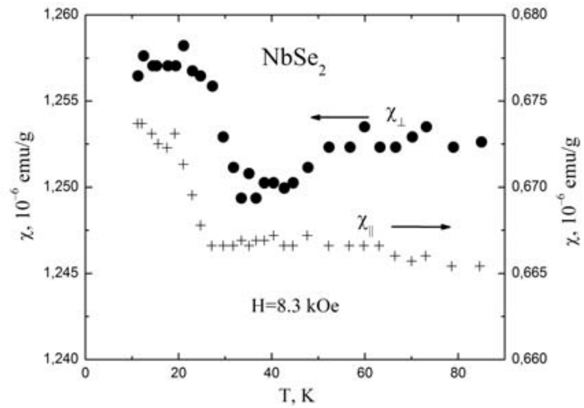

FIGURE 2. Magnetic susceptibility in the *c*-axis (filled circles) and in-plane direction of 2*H*-$NbSe_2$ (The Faraday measurements).

The positions of the features on the measured temperature dependences of both magnetostriction derivative on temperature and of magnetic susceptibility in field parallel to the crystallographic layers coincide and are in the close vicinity to the charge density wave transition in this compound.

So, the occurrence of the observed peculiarities can be attributed to the physical processes in the crystals under study arised from the formation of the CDW state.

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