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HTSC-LIKE SUPERLATTICES PbTe-PbS MICROWAVE SPECTROSCOPY

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For the first time magnetic field nonresonant microwave absorption at 9.4 GHz in the thin film superconductive superlattices (001) PbTe-PbS (T_c=5,5 K) was investigated. These superlattices may be considered as structural HTSC models. It was found that absorption in the superlattices has similar peculiarities to ones in HTSC thin films. The influence of modulating magnetic field on the conditions of formation of various hysteretic absorption signals was analysed.

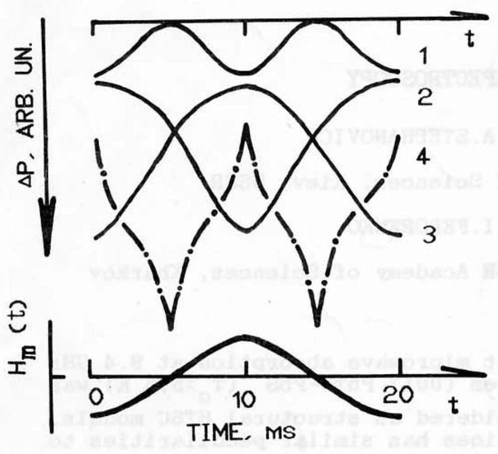
1. INTRODUCTION

EPR spectroscopy technique application to the investigation of the high-T_c superconductors (HTSC) leads to new investigations direction formation-HTSC microwave spectroscopy[1-3]. The aim of these investigations is to clarify the observed microwave response signals (MRS) nature and to determine the connection between MRS peculiarities and investigated samples parameters.

The epitaxial superlattices (SL) PbTe-PbS /(001)KCl are close structural analogs of YBaCuO-type system[4,5]. The SL samples, consisting of the ≃ 20 interchanged PbTe-PbS layers of 15-18 nm thickness were used. The experiments were carried out at T = 1.8- 10 K using the EPR spectroscopy standard technique at the frequency ν = 9.4 GHz with the aid of both modulational spectrometer ($\omega_m/2\pi$=100 KHz) and superheterodine one.

2. RESULTS

The form of direct microwave absorption signals at two modulation field amplitude values H_m both in absence and in presence of small constant magnetic field H_o is shown at the Fig.1. It can be seen, that at H_o = 0 and H_m = 0.05 Oe (curve 1) the responce at frequency $2\omega_m$ can be observed. At $H_o \geq 0.1$ Oe the responce at the frequency ω_m begins to appear. Its phase depends on H_o direction (curves 2 and 3). With H_m increase the signal, induced by H_o at $\omega = \omega_m$ is suppressed and the responce takes form (curve 3), the peculiarities of which are the intensive absorption peak near H_o = 0 and two symmetrical absorption decrease peaks near H_m extrema points. The signals $I(\omega_m)$, registered with the aid of lock-in detection at $\omega = \omega_m$ (Fig.2) are in close connection with mentioned peculiarities. The peculiarities, displayed at Fig.1 (curves 1 - 3) lead to hysteretic signal (curve 1 at Fig. 2). The hysteretic component suppression with H_m increase (Fig. 1, curve 4) leads to the signal at curve 2, Fig.2. It was established, that signals under consideration have unstationary nature and can be induced only by



FIGURE

Form of the direct microwave absorption signal in SL PbTe - PbS at different values of modulative H_m and constant H_o magnetic fields H_m,H_o,Oe: 1 - 0.05; 0; 2 - 0.05; + 0.1; 3 0.05; - 0.1; 4 - 3.0; 0 ($\omega_m/2\pi$ = 50 Hz, T = 4.2 K).

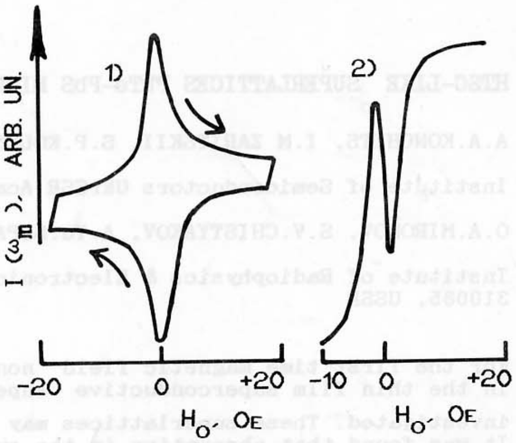


FIGURE 2

Form of the first harmonic signal. H_m, Oe: 1 - 0.03; 2 - 1.0 and gain is 1/5. $\omega_m/2\pi$ = 100 kHz.

alternating magnetic fields. The experimental data analysis[6] permit to conclude, that hysteretic component, observed at small H_m (Fig.1, curves 2,3; Fig.2, curve 1) cause by the microwave losses in superconducting state. The probable mechanism of microwave hysteretic losses for HTSC is considered earlier[7]. It connects with low frequency modulation of the Josephson junctions resistive losses from their H - field dependent parametrical inductivity. The additional reason of hysteretic losses in SL PbTe - PbS is that the superconductor at $H_{c1} < H < H_{c2}$ is in the critical state, when the role of inductivity plays H-field dependent inductivity of whole sample, and resistive part consists of Abrikosov vortices normal cores, H - field destroyed weak links and other normal parts of the sample. The inductive losses, connecting with stationary flux distribution destroying in the superconductor critical state and it's partial transition into resistive state (Fig.1, curve 4), appear with H_m increase. It also leads to hysteretic losses, registered by lock-in detection, first harmonic suppression (Fig.2, curve 2).

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