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$YBa_2 Cu_3 O_{7-x}$ Investigation of the Nature of Relaxation Phenomena in Ceramics

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ABSTRACT: High-temperature superconducting materials $YBa_2Cu_3O_{7-x}$ (YBCO) compounds are intently checked. Interest in this compound can be considered as a module of a number of high-temperature superconducting materials using the fact that the presence of parameters of high-temperature conductivity in it has a relatively simple synthesis as well as a simple crystal structure.

KEYWORD: High-temperature, superconducting, $YBa_2Cu_3O_{7-x}$ compounds, in electronics and production, a proper, scientific basis, increases economic efficiency.

INTRODUCTION

It consists in observing, comparing and studying the physical and nature of the acoustic anomaly in the 77-550 K temperature range, as well as relaxation phenomena in the $YBa_2Cu_3O_{7-x}$ compound. In order to achieve the above goals, issues were set in the graduation qualification work.

- Modernization for absolute values of absorption coefficient of ultrasound waves in acoustic echo-impulse method device.
- Comparison of structural relaxations and spatial transitions in $YBa_2Cu_3O_{7-x}$ compound based on the obtained results.
- Measurement of ultrasonic absorption at frequencies of 77-550K and 10-150MHz in ceramic and single crystal samples of $YBa_2Cu_3O_{7-x}$ compounds.

MATERIALS AND METHODS

In the temperature range of 77-300 K $YBa_2Cu_3O_{7-x}$ investigation of relaxation phenomena in ceramics. Examinations first after radiostructural analysis YBa_2Cu_3O (x=0-1) conducted on samples. Information about the tested samples is presented in Table 2. Due to the large absorption of ultrasound waves, the samples were prepared in the form of a thin disk with a thickness of 500 μm. The first-order amplitude of the ultrasound pulse (pulse periodicity is less than 1 μs) $YBa_2Cu_3O_{7-x}$ for series compounds, temperature dependence has been measured . Based on these data, it was determined that the absorption of ultrasound waves changes depending on the temperature. Ultrasound has different content $YBa_2Cu_3O_{7-x}$ anomalous

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absorption of ultrasound at 100 K temperature is observed in all spectra where temperature-concentration relationships are given in ceramics.

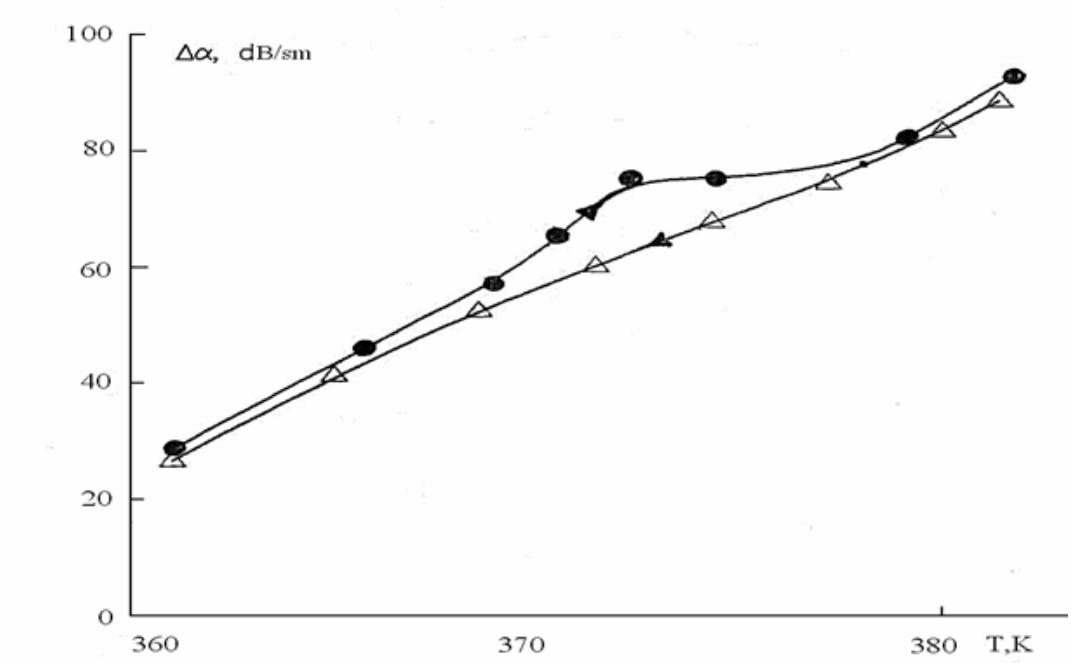

Figure 1. Longitudinal ultrasound wave $YBa_2Cu_3O_{7-x}$ temperature dependence of ceramic absorption. Anomaly at 30 MHz at 370 K

Figure 1 shows that the intensity and position of the absorption peaks at 100 K also depend on the amount of oxygen, and with the increase of the concentration, these peaks are attracted by the shift of the temperature towards the lower side. The frequency-dependent maximum peaks at 100K characterize the Debye relaxation dependence with the same time relaxation. The activation energy W and the frequency response Ω are determined using the following formulas.

$\tau=\tau_0 \exp(-W/k_b T)$ (1)

$\Omega=\Omega_{eff} \exp(-W/k_b T_m)$ (2)

Here k_b is the Boltzmann constant T_m for the peak at the maximum temperature of 100 K and the frequency response W~ 0,112V va $\Omega \approx 5*10$ C^{-1} is equal. Anomalous absorption of ultrasound at 100K in other works [1] was also observed. The observed deviations, according to a number of authors, describe structural changes in high-temperature superconducting materials. Some and the authors explain this anomaly by the fact that the crystal lattices in the compound are not exactly stable at the temperature limit of the transition to superconductivity T_c. Based on the above, the following conclusion can be drawn. 62K temperature at frequencies of 1kHz at small values of oxygen obtained thermoactive relaxation maximum values are consistent with the values of W and Ω at 100K temperature. The dependence of the maximum values found in the above samples on the oxygen dependence and intensity of W and Ω of the Arrenius parametric shows that this peaks are formed from thermoactivated jumps of oxygen atoms in the plane 0 (1) -0 (5). Similar conclusions were made in the work [1]. Of low temperature Spectra $YBa_2Cu_3O_{7-x}$ characteristic of ceramics side is the presence of temperature hysteresis of absorption in the temperature range of 230-80K

At the same time, the absorption curve is always higher when heated than when cooled. Greater hysteresis is observed only at temperatures below 200K. Figure 1 shows the dependence of ultrasound wave absorption on

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frequency and temperature $YBa_2Cu_3O_{7-x}$ for ceramics (different amounts of oxygen) and in the temperature range of 230-80K ultrasound it is shown that the absorption depends on the temperature.

Low-temperature spectra characteristic of $YBa_2Cu_3O_{7-x}$ ceramics side is the presence of temperature hysteresis of absorption in the temperature range of 230-80K At the same time, the absorption curve is always higher when heated than when cooled. Greater hysteresis is observed only at temperatures below 200 K.

Figure 10 shows the dependence of ultrasound wave absorption on frequency and temperature for $YBa_2Cu_3O_{7-x}$ ceramics (different amounts of oxygen) and the temperature dependence of UT absorption in the temperature range of 230-80 K.

Figure 2. Temperature dependence of absorption of longitudinal ultrasound waves in YBa_2Cu_3O ceramics. (different values of x-concentration of oxygen) temperature hysteresis is shown only for $YBa_2Cu_3O_2$ ceramics.

The nature of the low-temperature anomaly is not yet clear, but is related to some first-order spatial transitions. In this temperature region, strong jumps occur in the parameters of the crystal lattice.

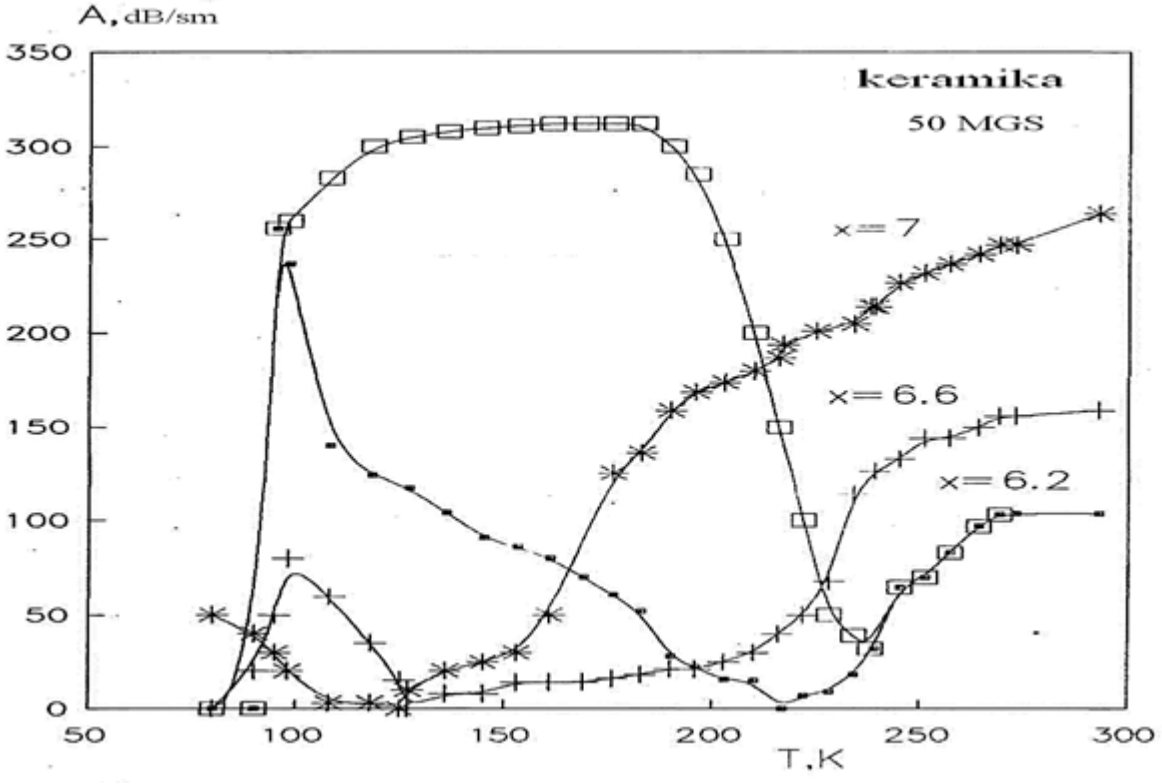

Figure 2.

CONCLUSIONS

Based on the work done and the analysis, we can see that the anomaly of ultrasound absorption observed around the temperature of 430 K is related to the defects of the ultrasound wave. It can be concluded that such defects, i.e. deficiencies, can be oxygen ions in the "Copper-oxygen" chain. The ultrasound wave disrupts the position of ions, as a result of which ultrasound absorption causes a relaxation phenomenon. —It

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is possible to conclude about the anomaly of ultrasound wave at low temperatures. Broad peaks around the temperature of 100K and 250 K are not related to electron relaxation, but to the character of ions. The huge absorption hysteresis in the temperature range (230-80) K is probably related to the first-order structural spatial transition.

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