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LOW TEMPERATURE ANOMALIES OF INTERNAL FRICTION IN OXIDE CERAMICS

The paper contains the experimental results for acoustic spectra of internal friction for a series of polycrystalline samples of oxide ceramics La–Sr–Cu–O and Y–Ba–Cu–O and also for pure solid oxygen in a wide temperature interval.

Comparison of the internal friction spectra of the studied samples prepared under different conditions and measured at various frequencies reveals that three peaks exist at the temperatures of 20–55 K for all samples including pure solid oxygen. In the last case, these peaks are due to well known phase transitions in solid oxygen at temperatures $T_{\alpha\beta}$ = = 23.88 K, $T_{\beta\gamma}$ = 43.78 K and T_{tr} (triple point temperature) = 54.36 K. Nature of these low-temperature anomalies in ceramics was not discussed by authors. Therefore, we can conclude on the base of comparative analysis of these results that the peaks are caused by both condensed oxygen in closed pores of the ceramics and oxygen absorbed by the surface of open pores and accumulated in structure defects, i.e. grain boundaries. Such a conclusion is supported by internal friction spectrum for single crystal of $YBa_2Cu_3O_{7-x}$, which does not reveal any peaks at the temperatures below 90 K. Detailed calculations of oxygen amount that can be released by the sample during it heat treatment are presented.

The analysis shows that solidified gases (i.e. oxygen, hydrogen, methane etc.) are very good indicators for study of gas-saturated solids. Presence of low temperature internal friction anomalies at the temperatures of phase transitions of the given solidified gas allows both to determine a gaseous medium contained by the studied objects and to define qualitatively the value of their porosity.

Keywords: internal friction, crystalline oxygen, phase transitions

Fig. 1. Temperature dependences of internal friction in the HTSC ceramics $La_{1.8}Sr_{0.2}CuO_4$ (*a*) and $YBa_2Cu_3O_{7-x}$ (*б*) obtained at the frequency of 60 kHz (*a*) [4] and 100 kHz (*б*) [5]. Curves *1*–*3* correspond to three types of the samples prepared by different technologies (*1*, *2* – «dry» technology, *3* – «wet» technology)

Fig. 2. Temperature dependence of LTIF of the $YBa_2Cu_3O_{7-x}$ ceramic sample at the frequency of 20 Hz [6]

Fig. 3. Ultrasound attenuation spectrum for single-crystal $YBa_2Cu_3O_{7-x}$ [15]

Fig. 4. Temperature dependence of LTIF of crystal oxygen obtained at the frequency of 4–8 Hz [12,16]