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AUTOMATIC SYSTEM OF RELAXATION SPECTROSCOPY

An original setting for relaxation spectroscopy of functional and structural materials is described, that allows investigation of the low-frequency internal friction (IF) and the shear modulus by the method of inverted torsion pendulum. In contrast to the existing analogue:

– the design of the reverse torsion pendulum ensures easy installation and eliminates the influence of the mass of the pendulum to the sample, reduces the temperature effect on the swing of the pendulum system, changes the frequency of oscillation, allows exploring cylindrical or prismatic samples of 50–100 mm in length and 1–6 mm^2 in cross-section;

– the presence of two systems of vibrational excitation of the pendulum and the use of light but rather rigid moving parts allowed to raise the upper limit of the oscillation frequency and to study the frequency dependence of IF in the range of 10^{-3} to 70 Hz in the modes of free damping or forced vibration of the sample without rewiring;

– the use of the cryostat combined with the furnace allows for continuous measurement of the temperature dependence of the shear modulus and IF in the temperature range of 100–1100 K at a fixed frequency, and the annealing of the sample directly in the apparatus;

– it is possible to switch off mechanical vacuum pumps during the experiment to remove the effects of vibration on the accuracy of measurements;

– the use of the differential photodiode with large linear dimensions in the registration system allowed to expand the dynamic range of the measurement of the sample deformation and to improve the accuracy of measurement of the amplitude dependence of BT in the range of the relative deformation of 10^{-6}–10^{-4} at a fixed temperature.

The plant can be used to study the properties of a wide range of materials (from polymers up to heavy-duty ceramics) and to solve the spectrum of physical problems: the measurement of attenuation coefficients and elastic moduli, the study of structural and phase transformations, elucidating of the mechanisms of deformation and relaxation in the materials under external load and temperature influence.

Keywords: inverted torsion pendulum, internal friction, shear modulus, relative deformation

Fig. 1. Appearance (*а*) and generalized scheme (*б*) of the automatic system for relaxation spectroscopy

Fig. 2. Scheme of inverted torsion pendulum with the elements of functional modules (see the transcript in the text)

Fig. 3. Block-scheme of the temperature control system: *1* – vacuum chamber; *2* – block devices; *3* – regulator; *4*, *6* – flanges of the working chamber and the cryostat; *5* – heat exchanger; *7* – working chamber; *8* – extension rod; *9* – cryostat; *10* – external furnace; *11*, *12*, *13* – heaters of the external furnace; *14* – sample; *15*, *16*, *17* – heaters of cryostat; *18* – nitrogen inlet pipe; *19* – knob; *20* – vessel with nitrogen; *21* – heater

Fig. 4. Block-scheme of the system for the registration of the sample deformation: *1* – light source, *2* – condenser, *3* – diffuser, *4* – adjustable slit, *5* – lens, *6* – differential photodiode, *7* – current–voltage converter, *8* – amplifier, *9* – regulator, *10* – mirror, *11* – pendulum