Relaxation of Extremely Superheated States of Liquids and Polymeric Compounds

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We are developing a new experimental approach to the study of the thermophysical properties of dielectric substances in extremely superheated (short-lived) states, and the relationship between heating function parameters and thermal stability boundaries for relaxing systems. The key feature of our approach is a selection of the heating function that enables one to evaluate the behavior of complex samples, such as working fluids and cured polymeric compounds, in a region of high temperatures unaccessible to presently available experimental techniques and simulations with satisfactory accuracy.

The study is based on the method of a controlled pulse heating of a thin wire probe – resistance thermometer. The heating power and probe temperature as functions of time are recorded in the course of the measurement. The characteristic time of the probe temperature increase is from 1 microsecond (thermal shock technique) to 10 milliseconds (constant power technique). The probe temperature is increased from 300 up to 1300 K. The heating function parameters are fitted to the conditions of a concrete task, taking into account the sample properties. Particularly, this method enables one to rapidly increase the probe temperature up to the chosen value, and to maintain this temperature during the time interval necessary for a measurement (on the order of 1 millisecond).

This report presents the results of a comparison between the thermal resistance and the short-time thermal stability for multicomponent liquids superheated with respect to the liquid-vapor equilibrium temperature, and for cured polymers superheated with respect to the temperature of thermal decomposition in a quasi-static process. The technique, based on the synthesis of thermal shock and the measurement of heating functions, has been used for the resolution of the initial stage of thermal decomposition in pulse processes. The proposed approach may serve as a useful method of fast testing of important samples (for example, oils and binders) working in risky temperature regions.