Measurement and Evaluation of Apparent and True Thermophysical Properties of Materials during Phase, Chemical, and Structural Transformation

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The peculiarities of many materials during heating at the wide temperature range are chemical, phase and structural transformations accompanied by latent heat effects. The main problems in investigation of thermal physical properties of these materials can be formulated as follows:

· How to measure apparent thermophysical properties during chemical, phase and structural transformations;

· How to determine true thermal physical properties required for heat and mass transfer calculations during chemical, phase and structural transformations.

The problem in experimental measurements of thermophysical properties is the impossibility of using steady state methods during time-dependent physical and chemical processes in the materials. Using of transient methods, for example hot wire or laser flash methods, is also incorrect, since the measurement process has to be started only after steady state temperature field is established in the sample, i.e. when the processes could be finished. The best way to measure thermal physical properties during the processes is measuring during monotonic heating which can be a model of real technology. These methods are applied widely for test of specific heat based on DSC analyses. The special standard ASTM E2584 was developed for apparent thermal conductivity measuring during monotonous heating/cooling. We discuss in this paper some limitation of the standard methods and describe novel methods and technique for measurement of thermal diffusivity, thermal conductivity, and specific heat during monotonous heating of the sample. Determination of true thermal physical properties is based on excluding of latent heat effects and modeling of apparent thermal conductivity and heat transfer mechanisms. Thermal diffusivity and specific heat of materials with different composition and density (ceramics, gypsum, and minerals) were measured in this work in the temperature up to 1700°C. True thermal conductivity was determined as a product of the measured thermal diffusivity, volume specific heat in which latent heat effect were excluded.