ANNOTATION

The course is designed for PhD students, young researchers, and specialists who use thermal analysis methods in their research activities. The results of thermal analysis allow for the clarification of the chemistry of dehydration reactions, decomposition, phase transitions, reduction, and oxidation; the determination of the purity of substances and the presence of impurities; the temperatures of phase transitions; and more, depending on the nature of the substances and the selection of specific experimental conditions. Additionally, it enables the calculation of the kinetic parameters of the decomposition process of the studied sample, the construction of phase diagrams, the determination of reaction enthalpy, the specific heat capacity of the investigated sample, and more. The method is suitable for studying both synthetic and natural samples.

The course program includes several modules: I. Basic concepts and essence of the methods;

II. Thermogravimetry (TG); III. Differential Thermal Analysis (DTA); IV. Combined TG-DTG-DTA measurements – capabilities, operating modes, result interpretation; V. Calorimetry (DSC); VI. Thermomechanical Analysis (TMA); VII. Kinetics – solid-phase reactions, mathematical methods for calculating kinetic parameters

Part I. "Basic Concepts and Essence of the Methods" includes a brief description of thermal analysis methods, historical notes, and terminology in thermal analysis.

Part II. "Thermogravimetry" covers fundamental principles and quantities, types of thermogravimetry – dynamic, isothermal, quasi-thermal; determination of DTG dependencies; interpretation of TG-DTG relationships; the influence of various factors on measurement results – sample preparation for analysis, types of crucibles, heating modes, gas environment, and instrumental errors.

Part III. "Differential Thermal Analysis" covers the essence of the method, types of differential thermal analysis (at high pressures, in vacuum, and in gas flow), reference substances, quantitative analysis, the influence of various factors on experimental results, applications, and limitations of DTA measurements.

Part IV. "Combined TG-DTG-DTA Measurements" involves determining the temperature ranges of transformations, accounting for intermediate and total mass losses during the decomposition of the studied sample or series of samples under a programmed regime; determining the temperature ranges for dehydration reactions, decomposition, phase transitions, reduction, oxidation, etc., depending on the nature of the substances and the selection of specific experimental conditions; and possibilities for determining the purity of substances and the presence of impurities.

Part V. "Calorimetry (DSC)" covers the essence and fundamental principles of calorimetric measurements, types of calorimetry – anisothermal, adiabatic, isothermal, differential, titration, heat-flow calorimetry, and flow calorimetry; interpretation of DSC dependencies – similarities and differences between DTA and DSC measurements; application of DSC for determining the heat quantity required for a given process, reaction enthalpy, specific heat capacity, and kinetic and thermodynamic parameters of phase and chemical transformations.

Part VI. "Dilatometry (Thermomechanical Analysis)" explores the essence of the method and measuring equipment, application of the method for determining the coefficient of linear expansion, parameters of phase transitions between two solid phases and solid-liquid transitions, amorphization temperature, melting, and crystallization.

Part VII. "Kinetics of Solid-Phase Reactions" covers the kinetics of solid-phase reactions, kinetics of heterogeneous chemical reactions, and mathematical methods for calculating kinetic parameters.