Study of glass by thermal analyses

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Thermal analyses are widely used in the study of thermal properties such as glass transition (the reversible transition in amorphous materials) and crystallization (nucleation and growth of crystals). Thermal properties are studied by methods DTA (differential thermal analysis), DSC (differential scanning calorimetry), TMA (thermomechanical analysis), thermodilatometry, and optical thermomicroscopy. Samples are measured by both non-isothermal (constant heating rate) and isothermal modes (constant temperature). [1]

The result of measurements are curves, which show dependence of heat flow (DTA, DSC) or displacement ΔL (TMA, thermodilatometry) on the time or temperature. These curves provide information about the change of physical properties, physical and chemical phenomena that take place in the sample during its heating, cooling or isothermal soaking time. Thermal stability, kinetic parameters (i.e. activation energy, frequency factor, Avrami parameter) for both the glass transition and the crystallization are calculated from obtained data [1]. From TMA and thermodilatometry measurement the first and second order phase transition, the values of coefficient of thermal expansion, viscoelastic behaviour, and softening temperature are obtained [2, 3]. Crystallization of transparent glassy sample (formation of nuclei, their dimensions, and crystallization front movement) was studied by optical thermomicroscopy [4].

[1] M. E. Brown, Handbook of Thermal Analysis and Calorimetry: Principles and Practice. Amsterdam, Elsevier Science, 1998.

[2] P. Mošner, K. Vosejpková, L. Koudelka. J. Therm. Anal. Calorim. 96 (2009) 469.

[3] K. Nitsch, M. Rodová. Phys. Stat. Sol. (b) 234[2] (2002) 701.

[4] K. Nitsch, M. Rodová, J. Therm. Anal. Calorim. 91 (2008) 137.