The Application of Differential Scanning Calorimetry (DSC) for Determination of Thermodynamic and Kinetic Properties of Pure Compounds and Mixtures

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Nowadays, Differential Scanning Calorimetry (DSC) has won a lot of attention from researchers in the field of thermodynamics. The DSC devices are widely available, and simple in operation and sample preparation. At the same time, the increasing amount of experimental publications applying DSC significantly increased the number of publications where the results of the DSC technique are incorrectly analyzed: peak *T* assessed as the temperature of phase transition, including fusion; application of a single heating run for evaluation of the melting properties of the sample.

One of the new applications of the DSC technique is the study of solid-liquid equilibrium (SLE) and the evaluation of phase diagrams for binary mixtures. Another is the effect of the heating rate on the determination of liquidus temperature, the temperature at which the last crystal of the solid phase is dissolved forming exclusively liquid phase. Under DSC conditions, the kinetics of dissolution play a crucial role in the evaluation of liquidus temperature. The SLE phase diagram for the binary mixture of naphthalene and toluene was studied using the DSC technique and compared with the recommended values from the IUPAC technical report. Additionally, the water + sucrose and water + potassium bicarbonate ($KHCO_3$) systems were studied. The dissolution and crystallization rates for sucrose and potassium bicarbonate are too slow in comparison with the DSC heating rates at which a reasonable signal-to-noise ratio can be reached. For these systems, the liquidus temperatures corresponding to the dissolution of sucrose and $KHCO_3$ cannot be recorded. However, the crystallization of water from the supercooled mixture can be achieved. The additional analysis applying the set of heating and cooling rates in DSC allows one to evaluate the equilibrium liquidus temperature.