PCM-Screening: Thermodynamic modeling and experimental methods

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Thermal energy storage is becoming increasingly important with respect to the energy transition and the progressing application of regenerative energies. At that, suitable storage systems shall give significant contribution to compensate efficiently natural fluctuations of heat supply and need. Among the phase change materials (PCM) for latent heat storage in which the reversible melting and crystallization process is applied, inorganic salts and salt hydrates prove advantageous particularly due to their high heat of fusion, their low prizes, the non-toxicity, and the non-inflammability [1]. Nevertheless, there are some restrictions in thermochemical behavior, that require effortful thermal measurements for identification and characterization of applicability of potential PCM [2]. Thus, inorganic salts show characteristic types of thermal behavior as glass formation, semi-crystallization, a large temperature hysteresis, and incongruent melting behavior (peritectic melt). The experimental search for optimum conditions for reversible melting and crystallization behavior is hence unrewarding.

In order to avoid time-consuming 'trail-and-error' procedures, a strategy of complementary theoretical and experimental methods has been developed within the project network "PCM-Screening" of the 6th energy research program. A new approach is presented to get insight into the phase equilibria of eutectic systems by means of thermochemical calculation (CalPhaD method) [3]. To reduce the high experimental effort for determination of thermal properties and further optimization of latent heat storage systems by standard methods (e.g. DSC), moreover a high throughput screening setup has been developed using infrared thermography [4, 5] (Fig. 1a). Thereby the heat radiation on the surface of a sample matrix is detected by an infrared sensor and can be displayed using different colors or contrasts (b). Further distinct analysis for each measurement point result in individual temperature curves (c and d) for samples which have been measured simultaneously under same conditions within the high throughput matrix.

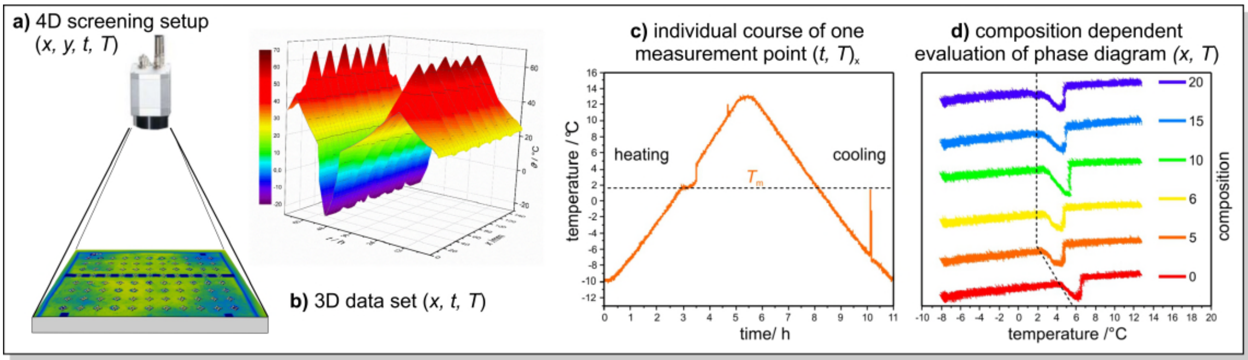

Figure 1: Determination of thermal properties by high throughput screening with infrared thermography setup. Scheme of reduction of complex data set (*x, y, t, T*) and evaluation of phase diagrams for one measurement run.

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