Calorimetric Measurements of Phase Change Materials (PCM)

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Phase change materials (PCM) are playing an increasing role on our way to a more energy efficient society. In buildings, where they are used in encapsulated form or in composite building materials, they can act as a short time temperature buffer or as a thermal energy storage, thus acting as passive conditioning elements. Similar usage can be found in the automotive sector. PCM do also increase energy efficiency when used as thermal storages in non-continuous industrial processes. Other uses for PCM are the buffering of temperature peaks in electronic devices and the transport of perishable goods, where they again act as a temperature buffer. In all these applications the exact knowledge of the thermal properties of PCMs will allow for the design of applications with a higher energy efficiency and lower costs.

One of the essential parameters is the latent heat of the PCM, i.e. the amount of heat stored or released during the phase change. When using differential scanning calorimetry (DSC), the most widespread caloric measuring technique, to measure PCM, some problems arise. These are strong supercooling in many cases due to small sample sizes, difficulties in the preparation of small, representative samples (e.g. hygroscopic salt hydrates) and corrosion with hermetic tight crucibles. Also hysteresis in the enthalpy-temperature curves due to the thermal conductivity of the samples and depending on the speed of the measurement, is problematic. Increased efforts were made to minimize these problems on different levels. First measuring recipes have been developed within the framework of the PCM RAL quality assurance RAL-GZ 896 in order to minimize uncertainties in the measured enthalpy values and to improve temperature accuracy for DSC measurements on weakly supercooling PCM. These include the preparation of the samples and set rules for the determination of a suitable heating and cooling rate. The IEA task 42 / Annex 29 then expanded on the rules given by the RAL procedure adding a calibration of the DSC, suggestions for sample preparation and suggestions for an improved analysis.

Finally different measuring methods have been developed in the last years focusing on the measurement of larger samples, with sizes close to the ones in applications and with different geometries. The most prominent new method in the PCM community is the T-History method, due to its relatively simple setup and evaluation. Other method have also been examined, such as the macro-DSC method, heat-flow meter calorimetry and bath calorimeters. This expands the measurement capabilities to encapsulated materials, strongly inhomogeneous materials and samples with almost arbitrary shapes and most importantly to application sized samples.