Standardization of Testing PCMs in Germany Status Report

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Content

- Why a need for standardization of testing
- What to standardize
- How to define testing procedures
- status in Germany
- Next steps

Why standardize testing?

Who needs standards for materials testing and quality control?

- R&D institutes for making the results comparable
- Producers to ensure product quality
- sales men for marketing and labelling
- customers to compare products
- to keep bad products from the market

First Step: in 2005 six companies founded the "RAL-Gütegemeinschaft PCM e.V."

with the goal to define a labeling scheme for Phase change materials and Phase change compounds (BASF, Rubitherm, Doerken, EMCO, SGL, Arcadis)

⇒ the ZAE Bayern and the Fraunhofer ISE were contracted to develop standardized procedure for testing and quality control

- Survey of common measurement techniques
- Perform an round robin test test
- Recommendations

Quality label granted by RAL in Spring 2006

www.pcm-ral.de

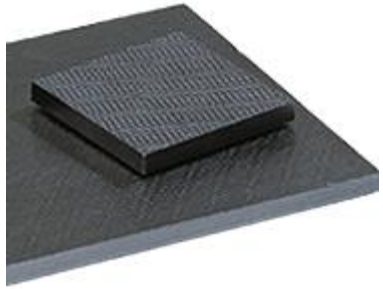
3 Criteria to measure

- Phase transition temperature and stored heat
- Heat conductivity
- Cycle stability

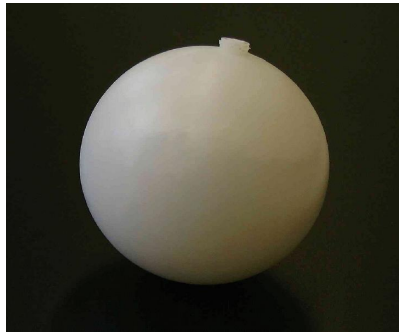
Defined for:

- PCM
- PCM compounds
- PCM Objects

rubitherm

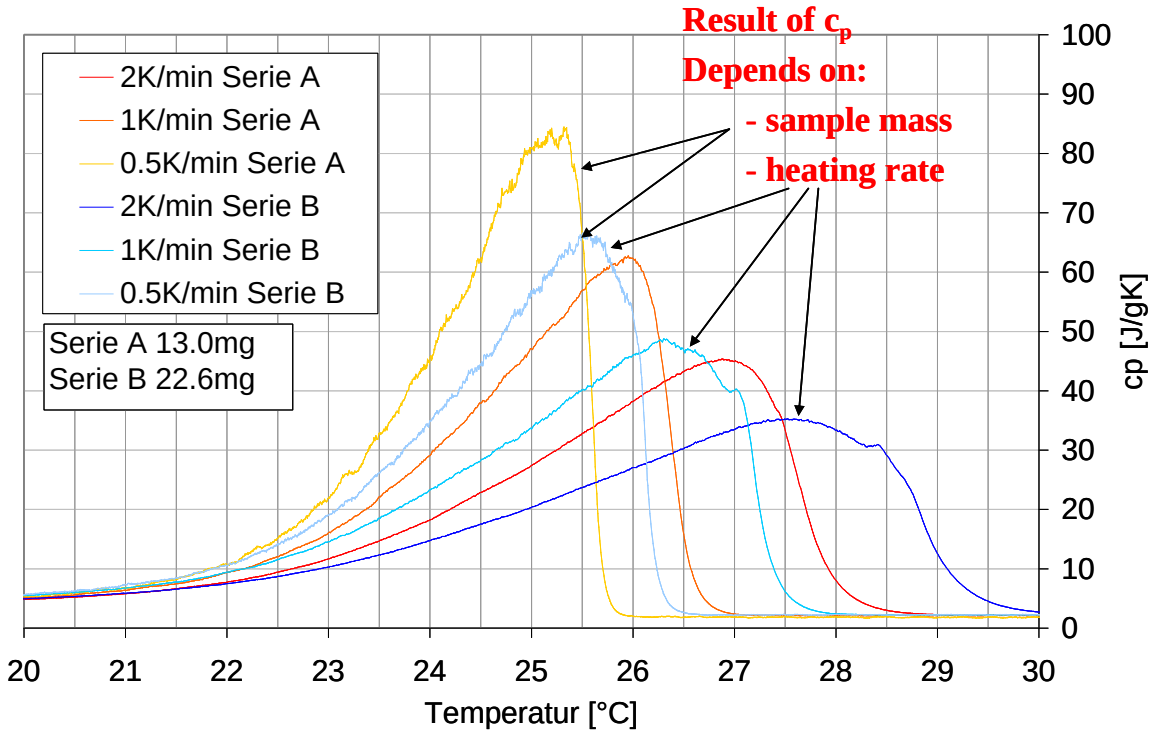


SGL



cristopia

Criteria 1: Temperature and enthalpy state of the art



Measurement with Hf-DSC in dynamic mode

Results depend on
- **sample mass**
- **heating rate**

Accuracy of 0.5 C is not achieved!

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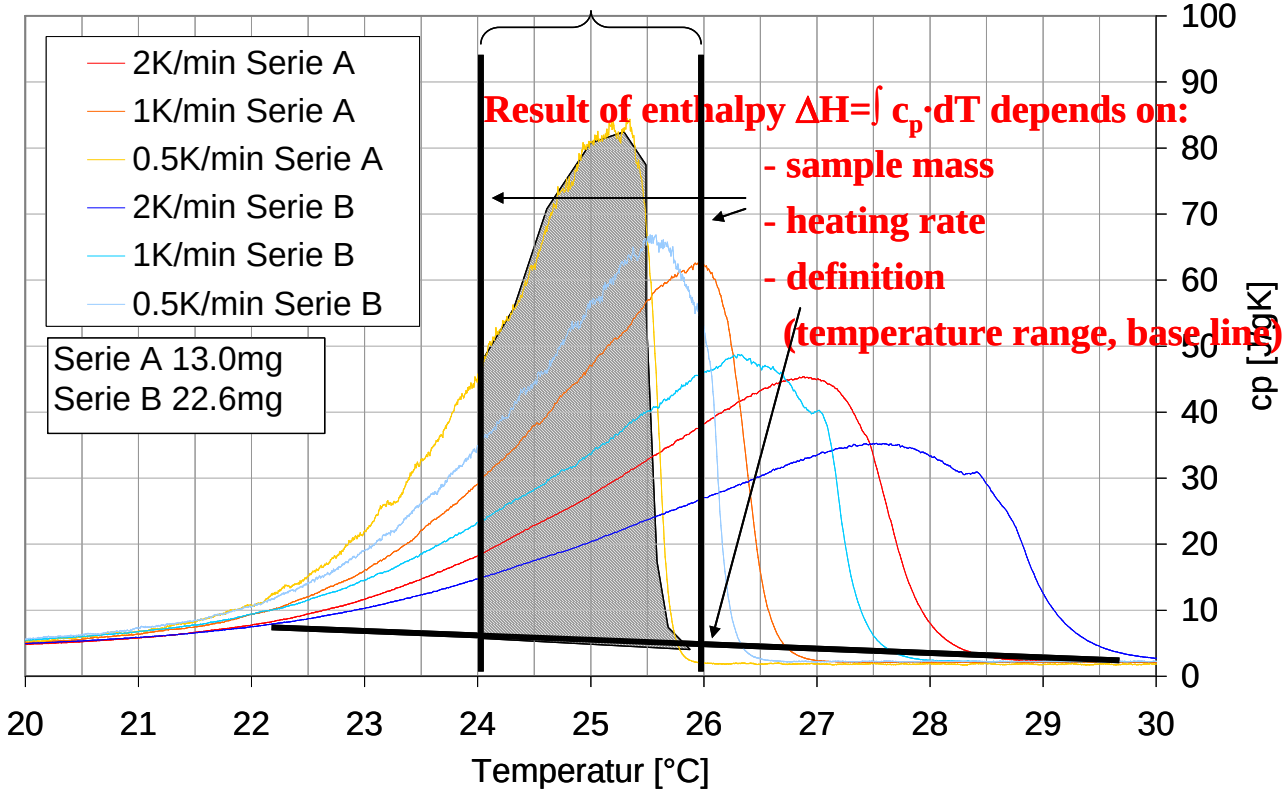
Tabulation of data:

Usually

T_{melt} and ΔH



What is the temperature range for ΔH?

Is it with / without sensible heat, that is the "phase change enthalpy" or "enthalpy during phase change"?

What is the melting temperature?

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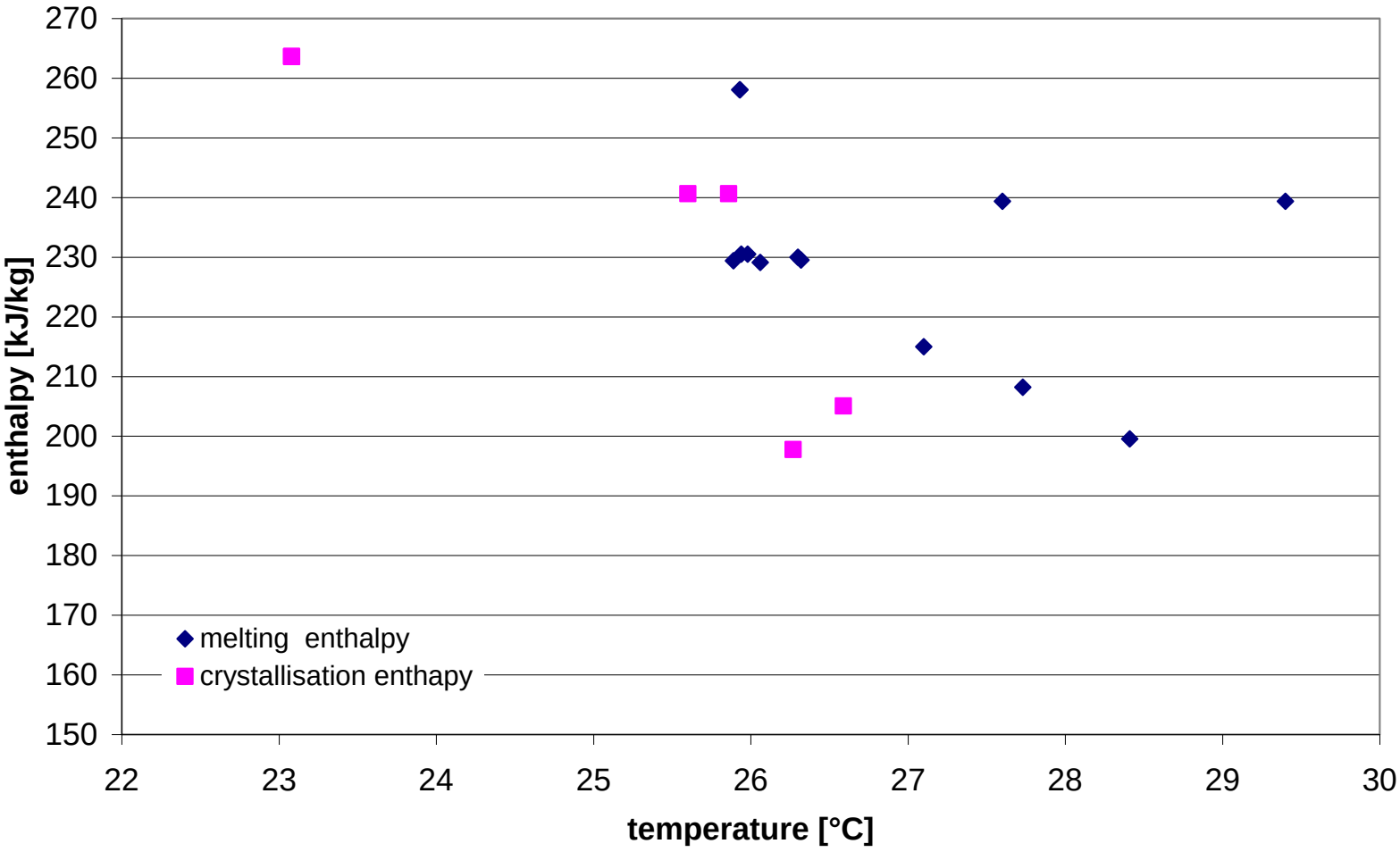
Round Robin Test started with several PCMs across several labs….



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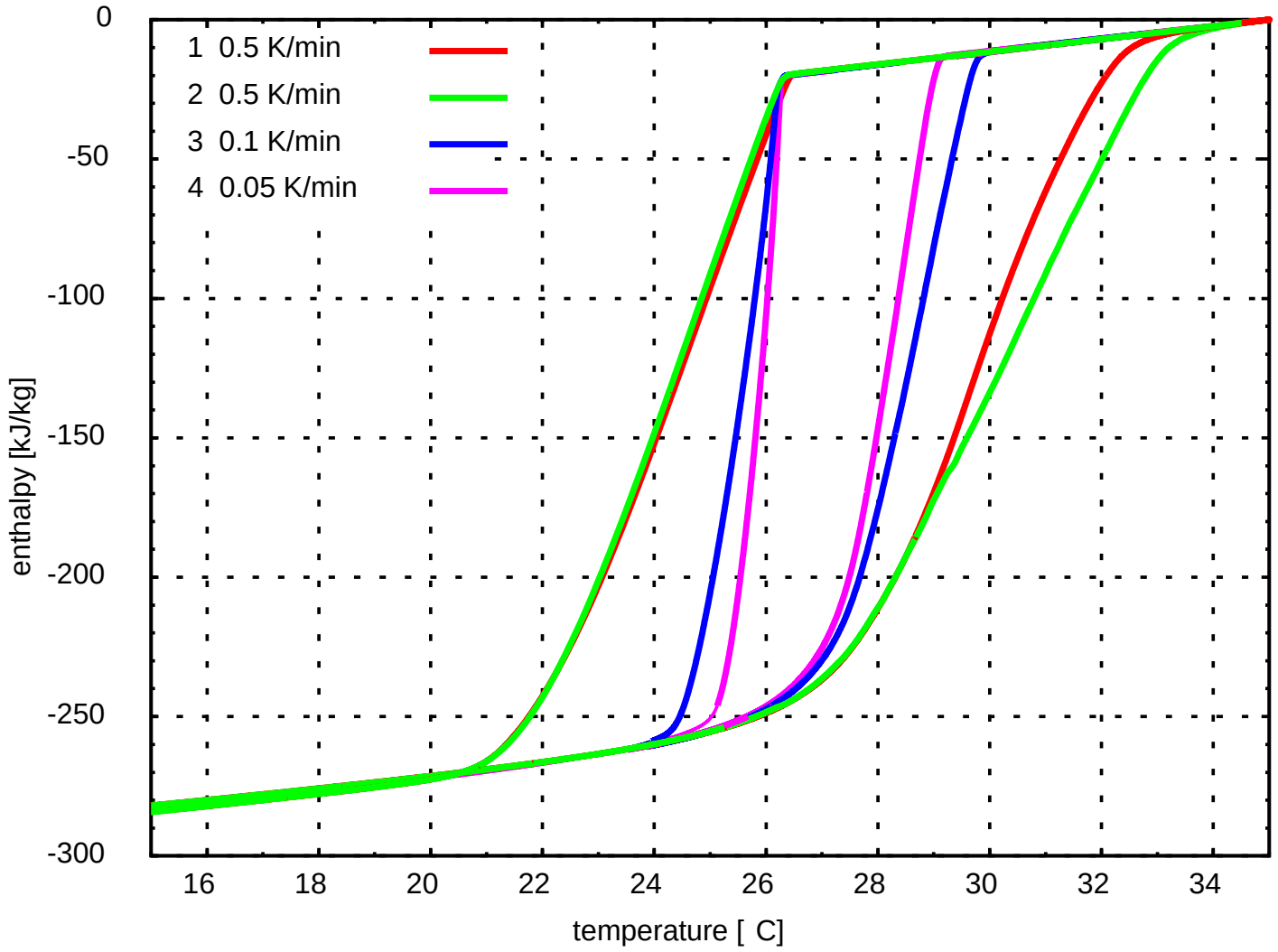
DSC results, influence of heating/cooling rate



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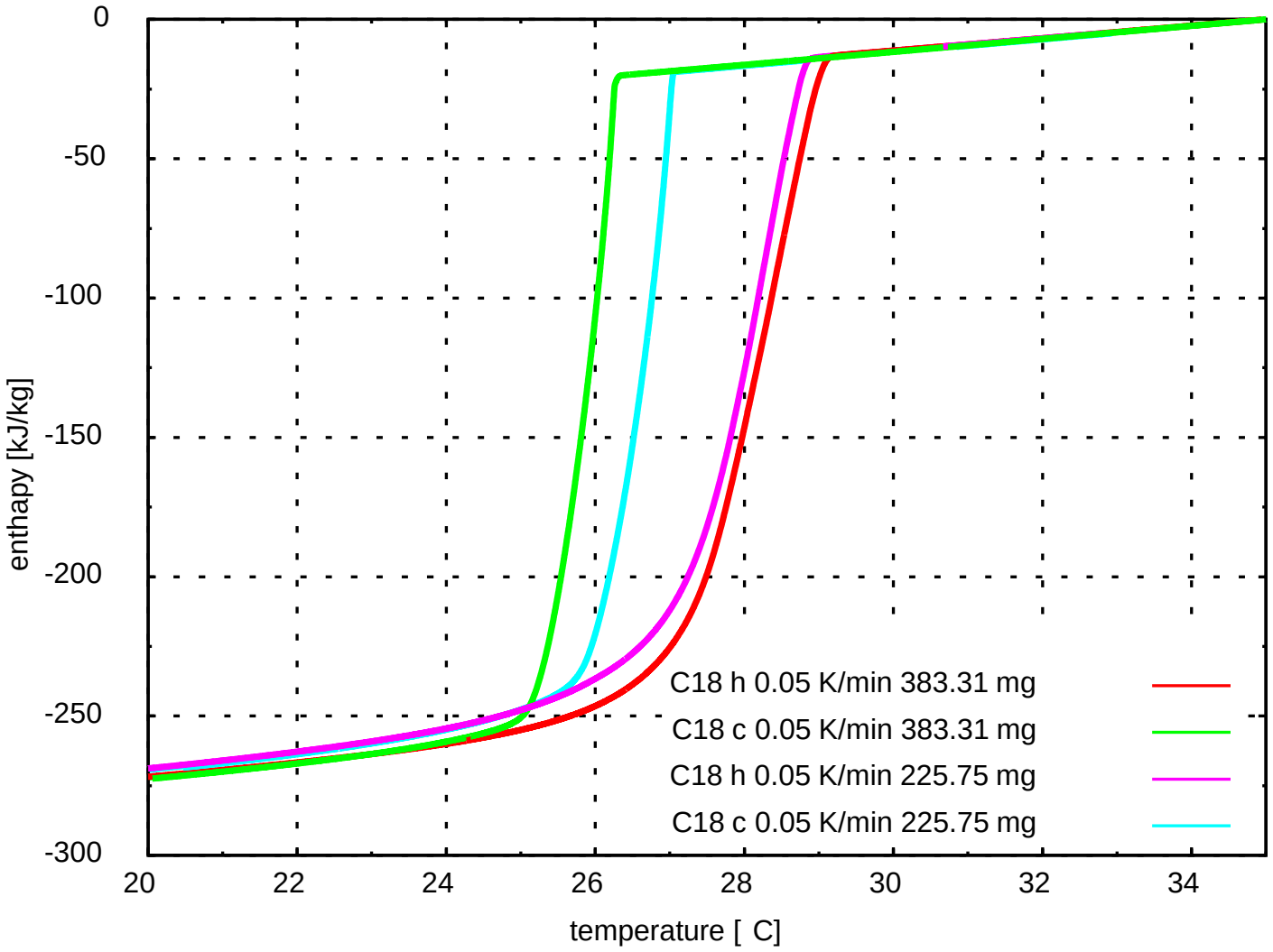
DSC results, influence of sample mass



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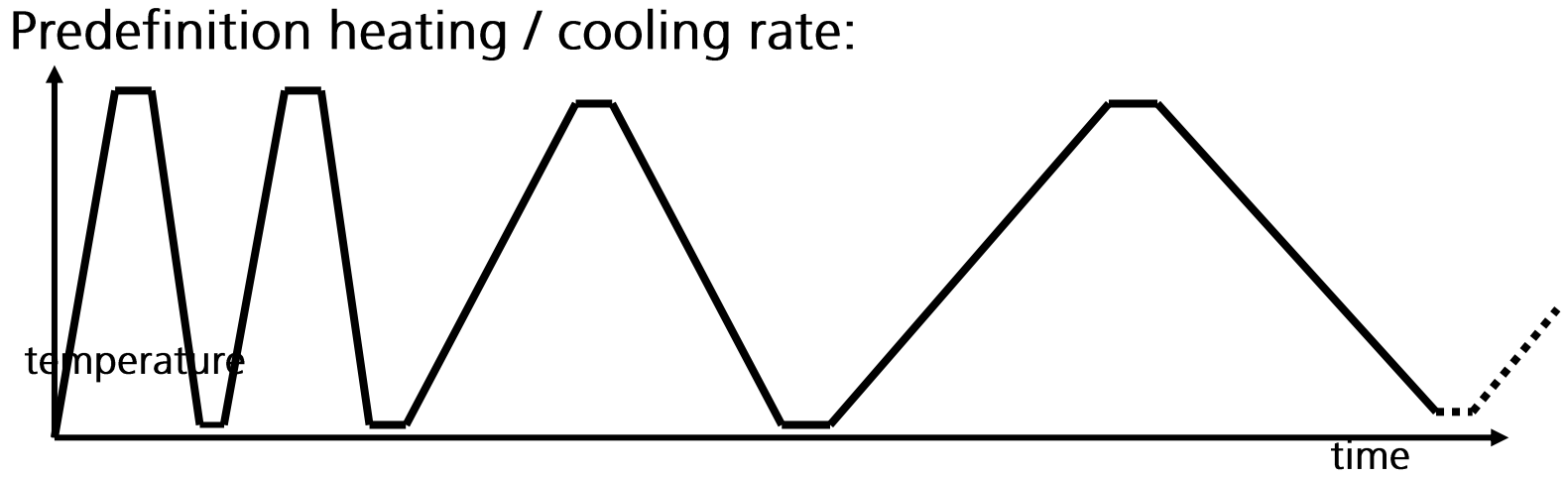
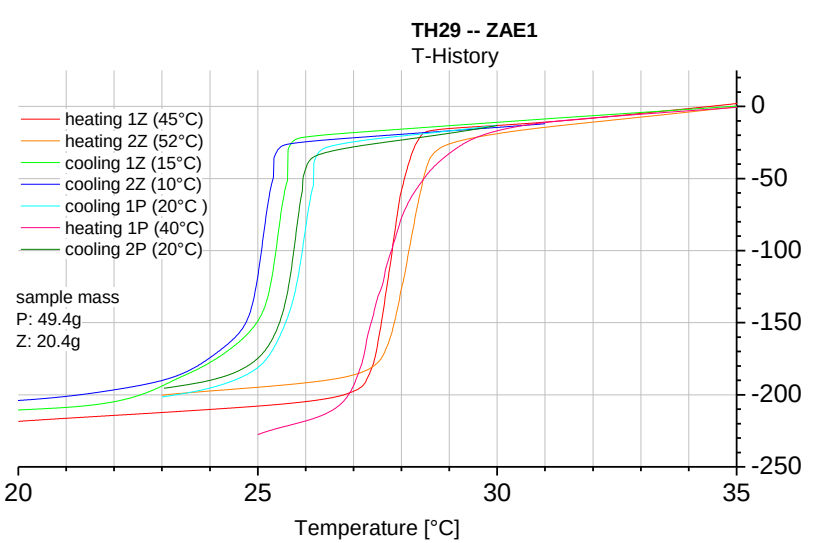
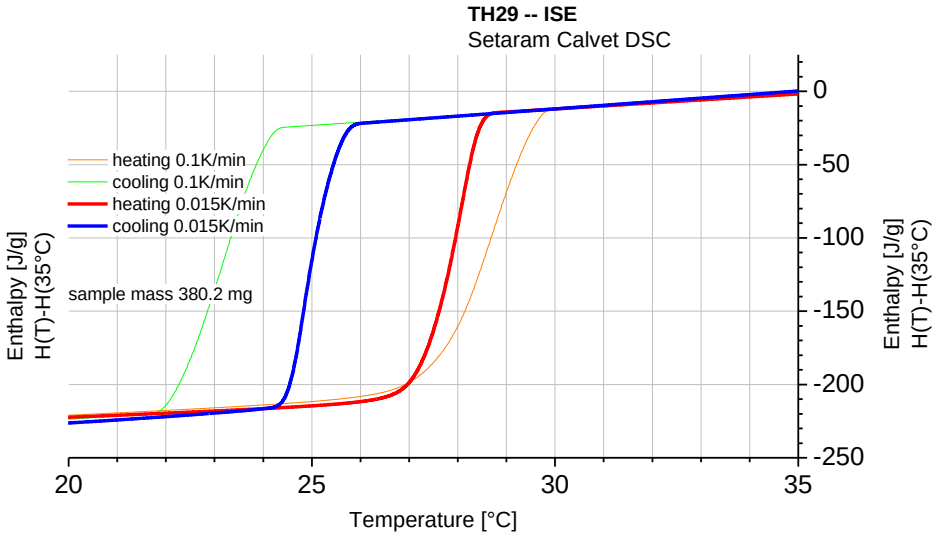
Standardized procedure



1. two fast heating and cooling ramps
   - ➔ determine the width of the peak (offset – onset)
   - ➔ the lower return temperature is offset (solidification) - 3 x “peak width”
   - ➔ the upper return temperature is offset (melting) + 3 x “peak width”
2. go down with the heating / cooling rate until the changes in temperatures are below 0.5K (peak temp., start temperature of solidification)

Comparing different methods on a salt hydrate with subcooling





heating and cooling data from measurements with very different masses agree within 0.5°C

⇒ thermodynamic equilibrium

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How to present the data

Target: accurate, simple to understand, precise!

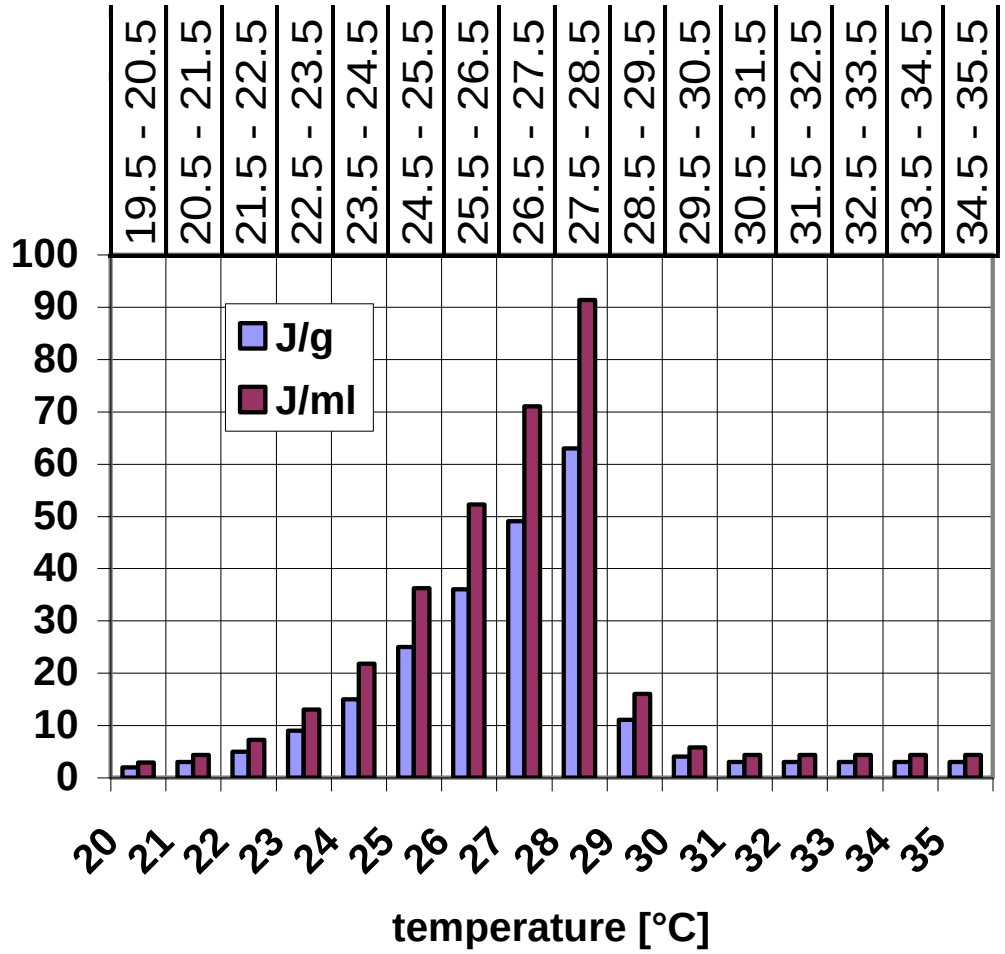
The stored heat as a function of temperature has to be declared for the case of heating and for cooling, as in most cases differences are observed. ⇒ no problems with choosing a baseline

The stored heat has to be tabulated in given temperature intervals. ⇒ no problems defining interval for ΔH and melting temperature

This has to be done with respect to

- mass in J/g
- volume in J/ml

The volume specific values have to be calculated from the mass specific values my multiplication with the smallest density in the temperature range of application. For example:



Temperature interval [°C]	stored heat [J/g]	stored heat [J/ml]
19.5 - 20.5	2	2.90
20.5 - 21.5	3	4.35
21.5 - 22.5	5	7.25
22.5 - 23.5	9	13.05
23.5 - 24.5	15	21.75
24.5 - 25.5	25	36,25
25.5 - 26.5	36	52,2
26.5 - 27.5	49	71,05
27.5 - 28.5	63	91,35
28.5 - 29.5	11	15,95
29.5 - 30.5	4	5,8
30.5 - 31.5	3	4,35
31.5 - 32.5	3	4,35
32.5 - 33.5	3	4,35
33.5 - 34.5	3	4,35
34.5 - 35.5	3	4,35
min. density [g/ml]	1.45	

Further on, the degree of subcooling for the selected temperature range of application has to be declared.

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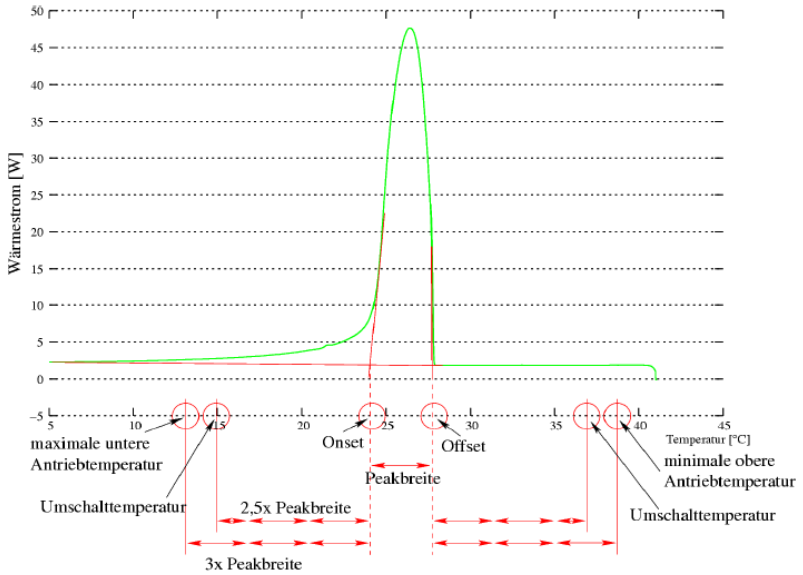
Cycle stability

To be defined:

- What is a cycle ?
- What is a damage ?
- How to measure the damage ?
- How many cycles needed?



Category name	Number of cycles
A	≥ 10,000 cycles
B	≥ 5,000 cycles
C	≥ 1,000 cycles
D	≥ 500 cycles
E	≥ 100 cycles
F	≥ 50 cycles

Conclusion

- Proposal how to measure and present PCM Properties available at
- www.pcm-ral.de

- Several companies following this proposal, several products wearing that label
- More companies joining (latest Capzo 2010)
- More companies welcome
- More institutes/universities following these procedures for their publications welcome

Next steps

- German engineer association VDI started group to define guideline for PCM in buildings „VDI 2164 - Latentspeichersysteme in der Gebäudetechnik”

- IEA SHC Task 42/ECES Annex 24 started working group on measuring storage materials

- First companies think about an european CUAP-procedure for PCM-building products (Common Understanding of Assessment Procedure)

- Very important: bring PCM into building codes and incentive programs