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# Determination of the isobaric mass heat capacity of polytetrafluoroethylene powder by differential calorimetry with temperature modulation (DSC-TM) for a large range of temperature

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## INTRODUCTION

Polytetrafluoroethylene (PTFE) can be used for long life photovoltaic applications [1] and for thermal energy storage as well [2], where heat capacity is an important parameter. From a technological aspect, powders can be used, packed together forming a packed bed of which it is interesting to know the heat capacity. This study focuses on determining the heat capacity of PTFE powders using a DSC TA Q1000. Measurements were done in modulated mode, over a large range of temperature, from -176°C to 180°C.

## EXPERIMENTAL SETUP

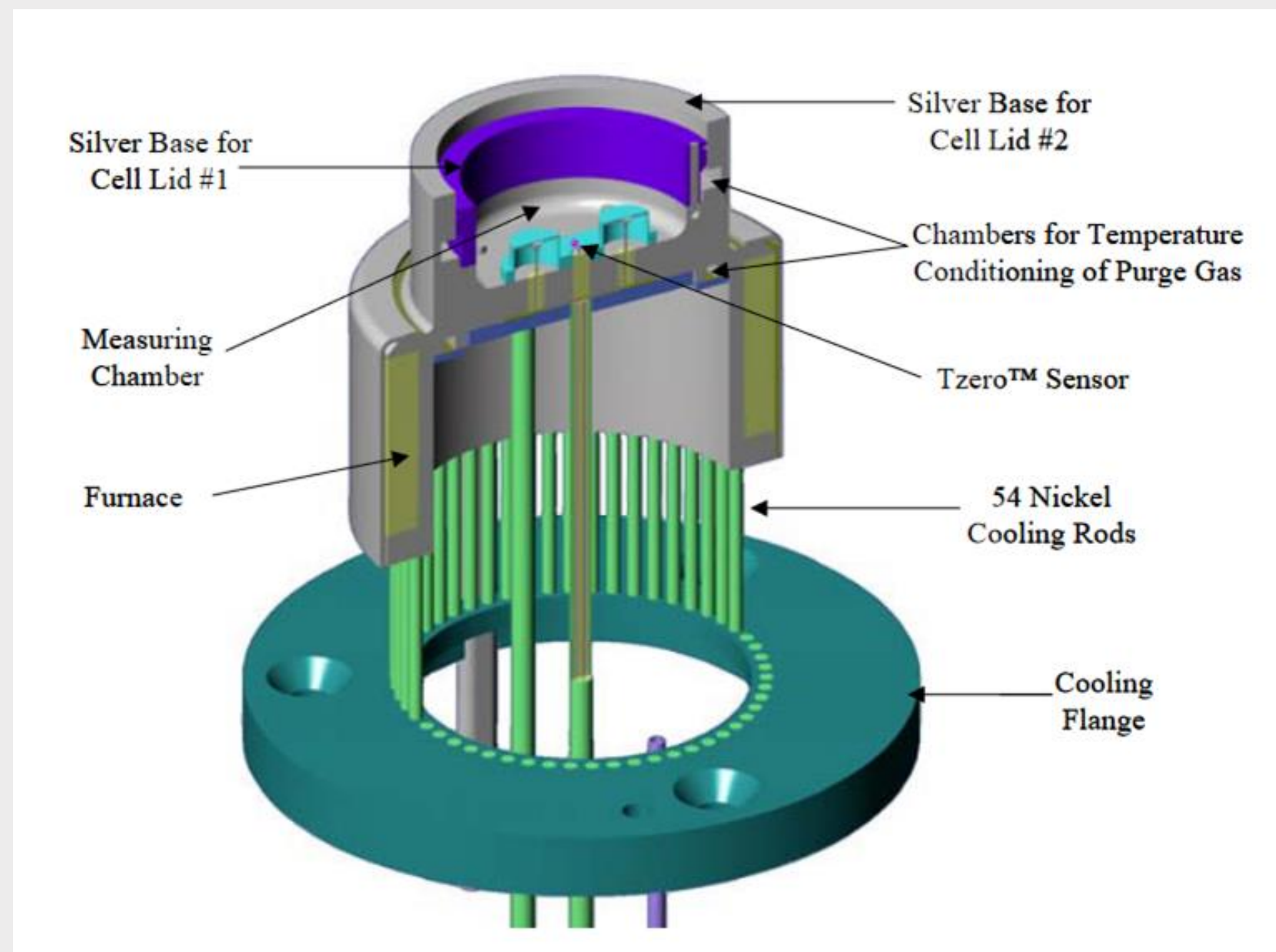


Figure 1: cross-section of a Tzero™ DSC Q1000 cell [3]

### Heat only Calibration

- ❖ Mode T4P
- ❖ Heating rate: 20°C/min
- ❖ Liquid nitrogen cooling system

### Gas used

- ❖ Base purge: Dry nitrogen gas
- ❖ Measuring chamber: Helium 5.0

### Calibration procedure

- ❖ Drying (75°C for 2 hours)
- ❖ Stabilization
- ❖ Tzero™ calibration (empty cell then saphirs)
- ❖ Temperature and cell constant calibration (with indium)

### Measurement procedure

- ❖ Equilibrate at -176°C
- ❖ Isothermal for 2 min
- ❖ Modulate temperature ( $\pm 1^\circ\text{C}$  every 120 s)
- ❖ Ramp 2°C/min to 180°C

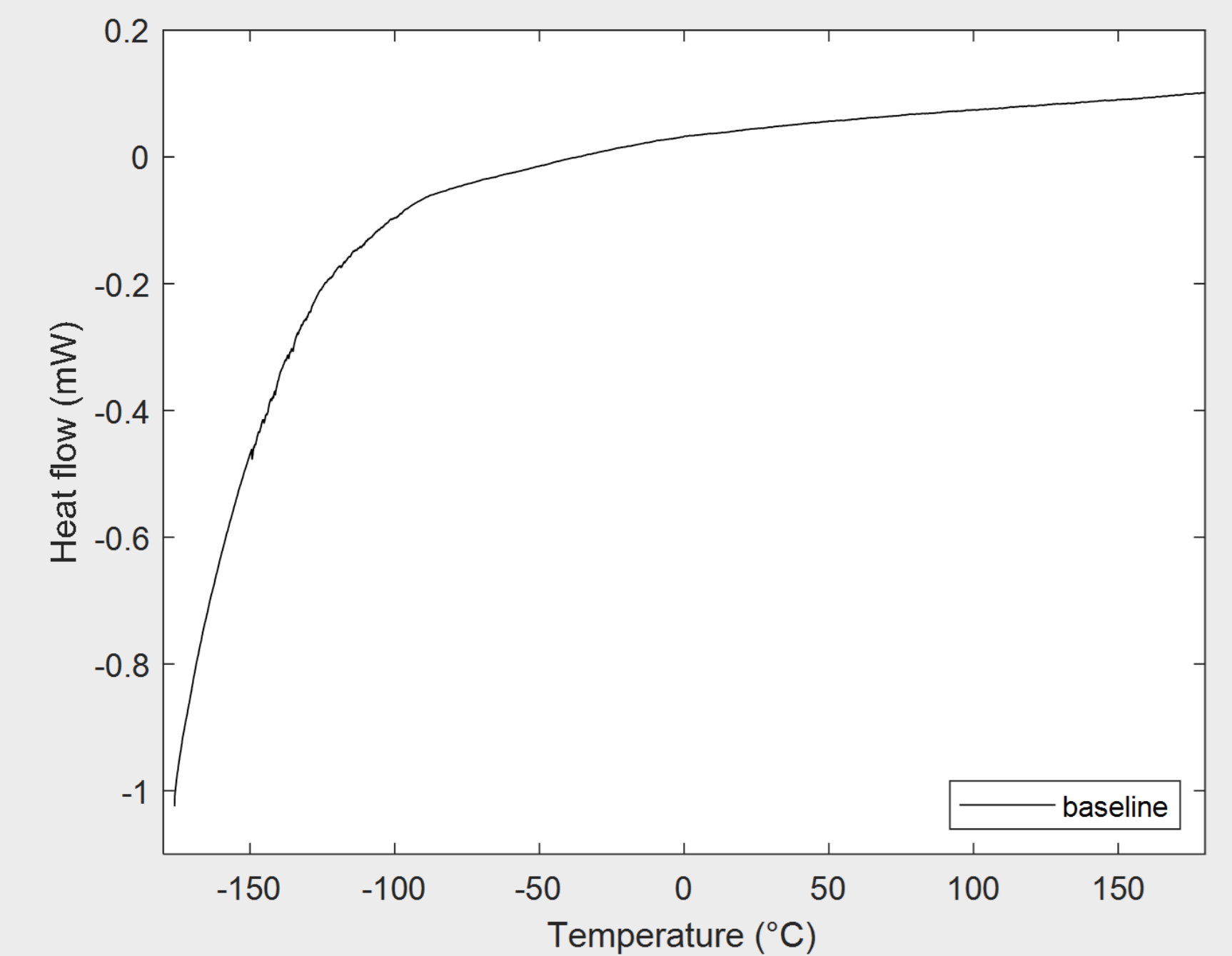


Figure 2: Baseline verification at 2°C/min (empty cell)  
Deviation between -100°C and 180°C: 0.5549  $\mu\text{W}/^\circ\text{C}$

## EXPERIMENTAL RESULTS

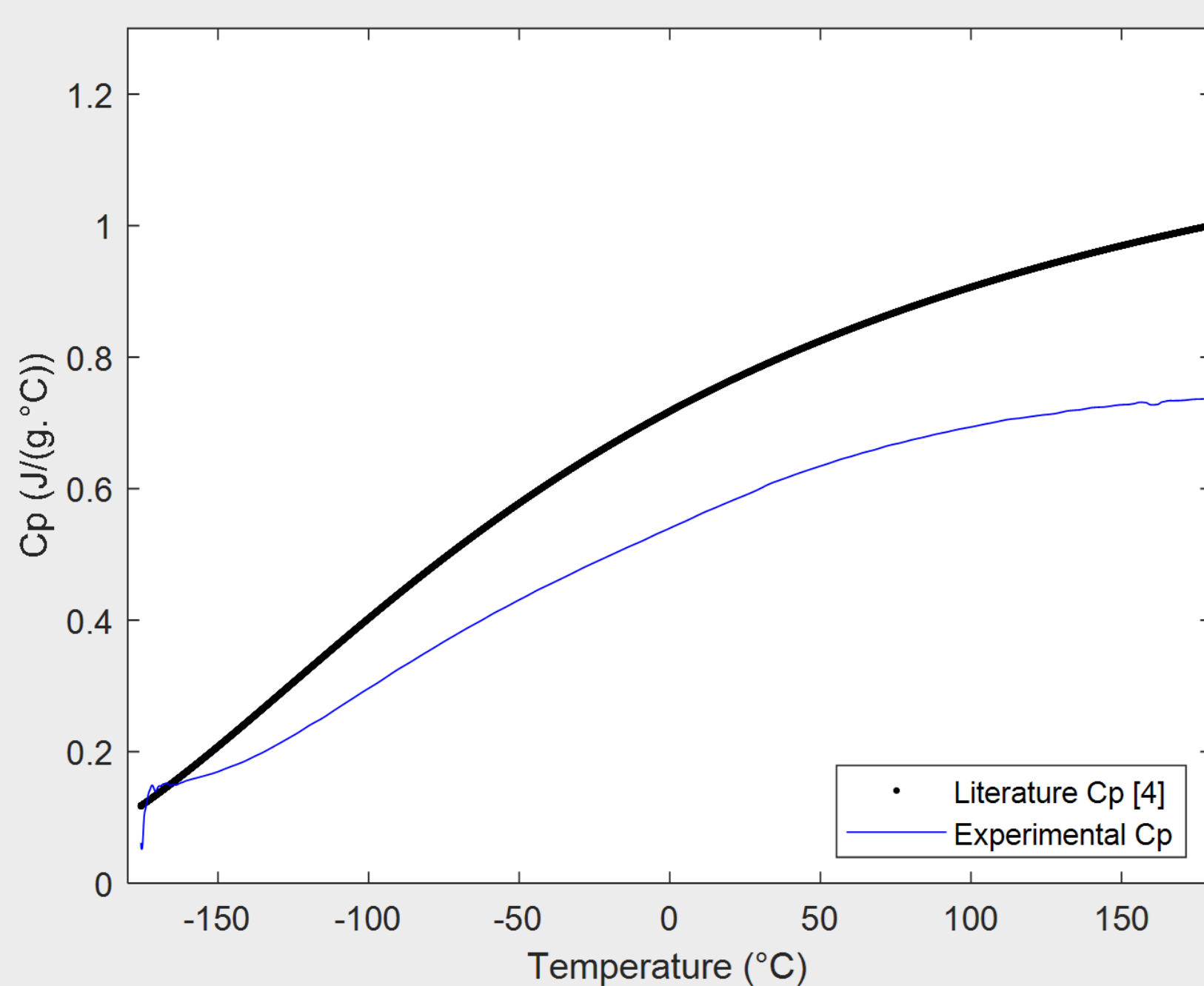


Figure 3: Experimental and literature Cp of 22.73 mg sapphire as a function of temperature

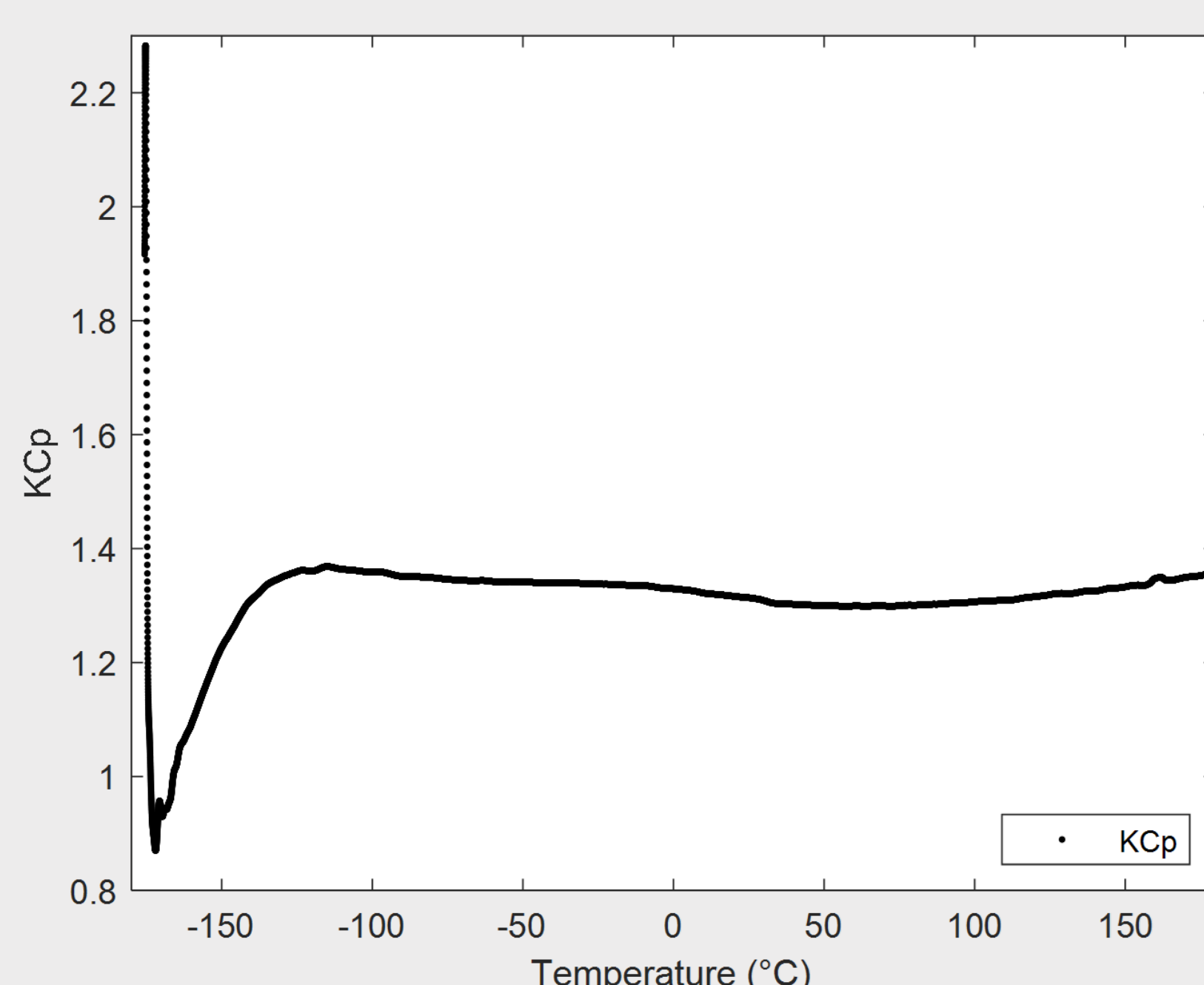


Figure 4: KCp of sapphire as a function of temperature

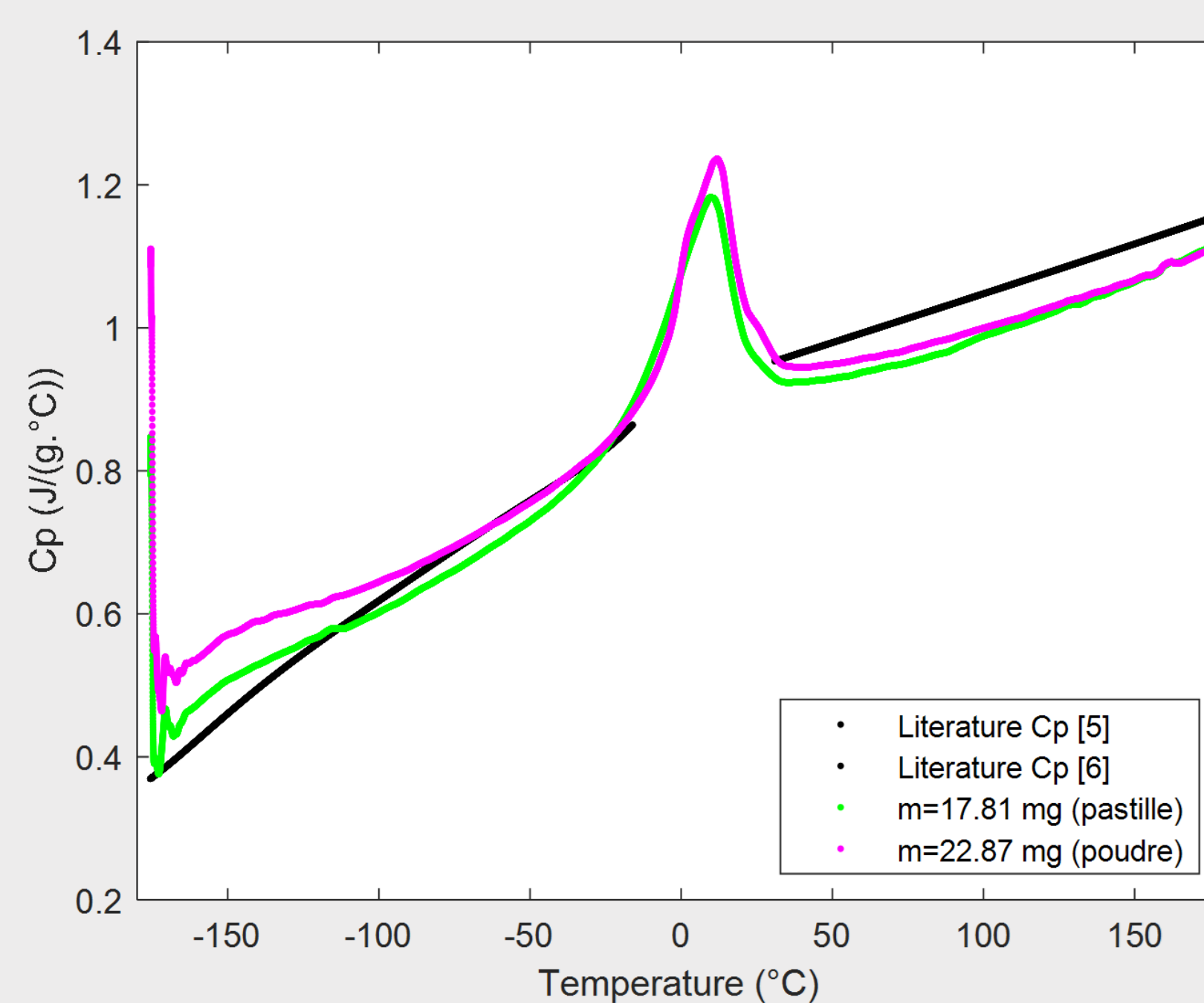


Figure 5: Cp of powdered PTFE compared to pelletized PTFE as a function of temperature

Pellet diameter (mm)	Pressure (GPa)	Mass (mg) ( $\rho=2.17\text{g}/\text{cm}^3$ )	Volume ( $\text{mm}^3$ )	Thickness (mm)
5	1.4	17.81	8.2	0.42
5	1.4	37.54	17.30	0.88
5	1.4	54.55	25.14	1.28
3	1.4	13.57	6.25	0.88
3	1.4	29.75	13.71	1.94

Table 1: pressure, mass, volume and height of each pellet with different diameter

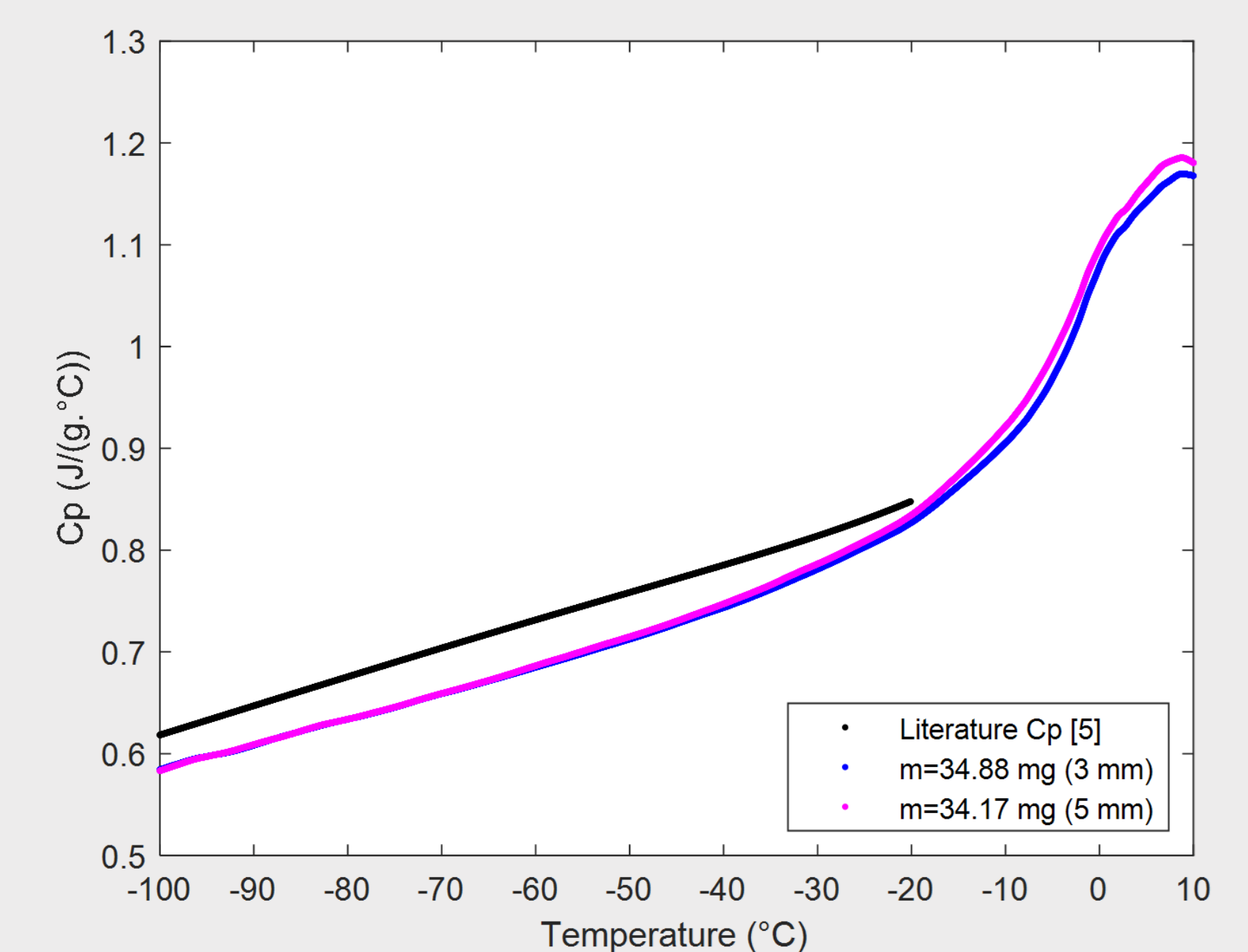


Figure 6: Cp of 3 mm diameter and 5 mm diameter PTFE pellets with the same mass as a function of temperature

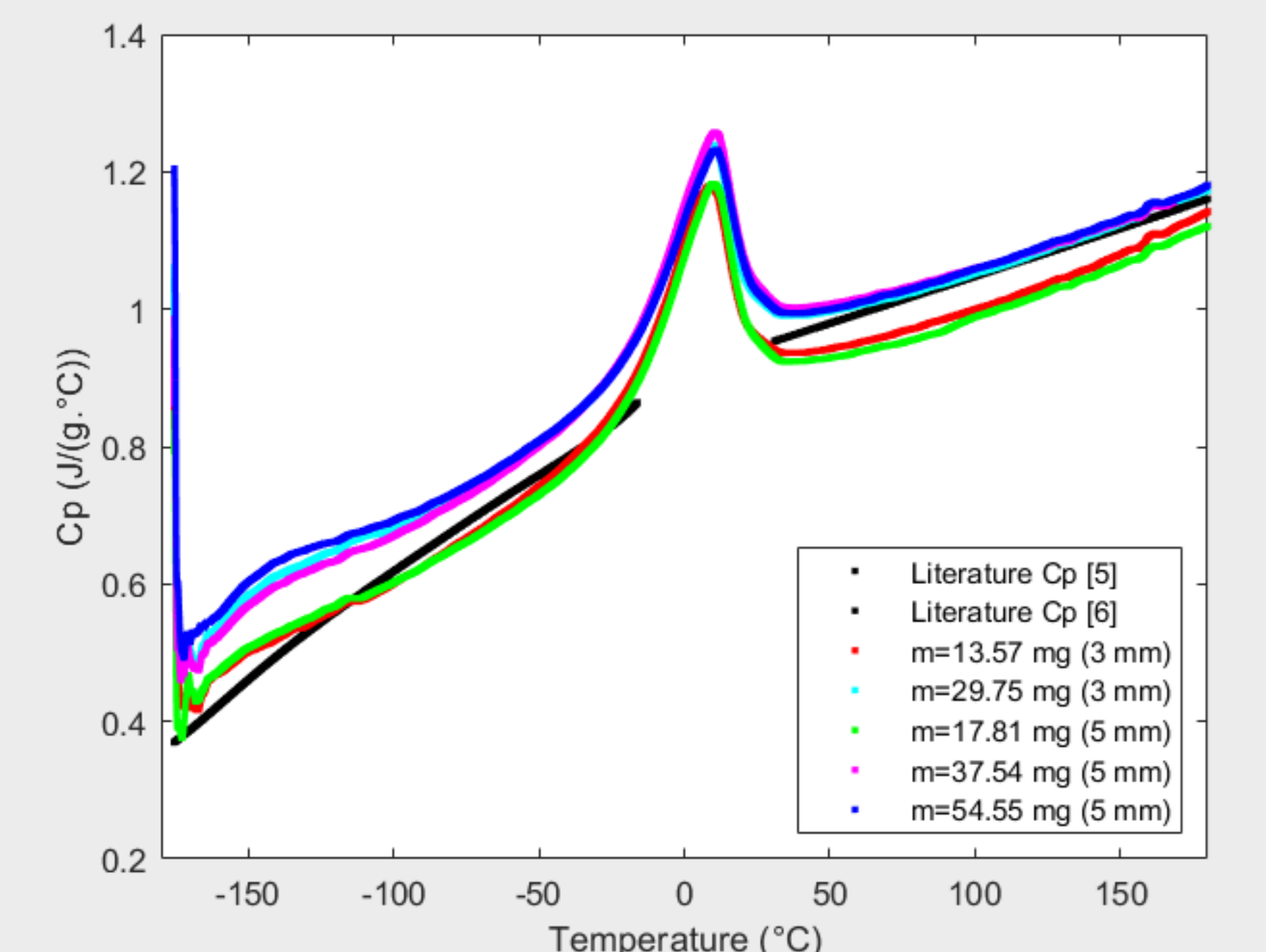


Figure 7: Cp of pelletized PTFE with 3 mm and 5 mm of diameter as a function of temperature

## CONCLUSIONS

- ❖ Pellets with the same mass have excellent reproducibility.
- ❖ The pellet diameter and thickness do not affect heat capacity values.
- ❖ Tzero™ calibration is an important feature for obtaining more accurate results.
- ❖ For the same mass, the use of a TA powder sample preparation kit does not provide sufficient reproducibility at low temperatures.

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