THERMOPHYSICAL PROPERTIES OF NWA 6255 (L5) CHONDRITE

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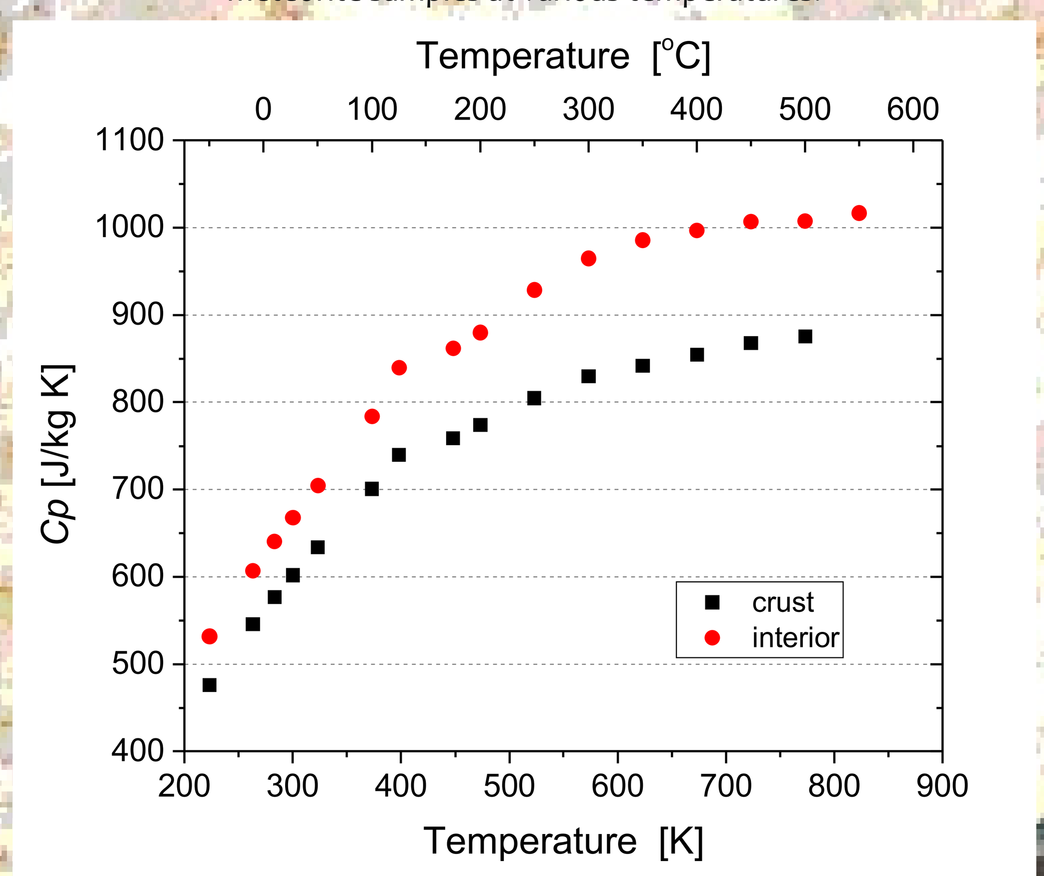
Introduction: Differential scanning calorimetry (DSC) is a useful technique for evaluation of thermal properties of matter, i.e. specific heat capacity, temperature and enthalpy of phase transformations, important for characterization of meteoritic minerals [1]. The aim of the study was to determine thermal properties of NWA 6255: specific heat capacity, the enthalpy and temperature of troilite α/β phase transitions, both as a function of distance from meteorite surface. The results of this investigation will allow for determination of temperature gradient during atmospheric passage of the meteoroid, and further facilitate simulation of such events for orbiting matter.

Fig. 1. Samples preparation for DSC measurements: selecting the crust, edge and interior parts of the meteorite (left), crushing & grinding the sample parts in the agate mortar (middle top), preparing 5 mg of homogenized sample in the crucible (middle bottom), crucibles in the DSC – reference and the sample (right).

Methods: Specific heat capacity (*Cp*) and characterization of phase transition of troilite were evaluated by DSC (Q200, TA Instruments). Two specimens of NWA 6255, one of the crust and one of the interior, were examined in the temperature range 223 – 823 K for *Cp* determination. In addition, the phase transition of troilite from: (a) the fusion crust, (b) the edge part of the meteorite (1 – 2 mm below the crust), and (c) the interior (over 10 mm below the fusion crust) was examined in the temperature range 373 – 473 K.

Fig. 2. Specific heat capacity, Cp of crust and interior [J/(kg·K)] of NWA 6255 meteorite samples at various temperatures.



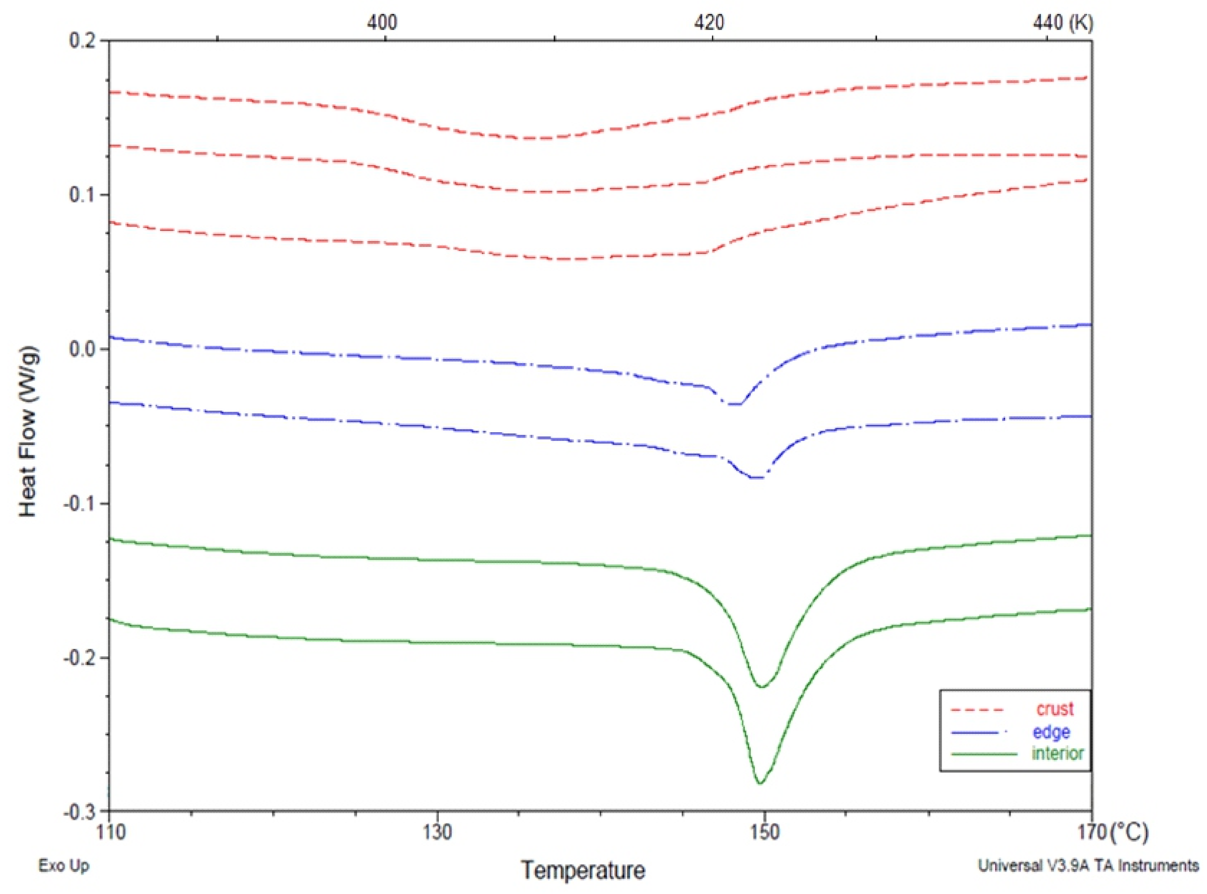


Fig. 3. Endothermic peaks of α/β transition of troilite from different parts of the NWA 6255 meteorite. DSC scan showing the heat flow during heating of the meteorite samples.

Results: Specific heat capacity of bulk of NWA 6255 was determined to be *Cp* = 668 J/(kg·K) at 300 K (Fig. 2) and is close to the value characteristic for stony meteorites [2]. *Cp* differs with spatial distribution in the meteorite, giving 602 J/(kg·K) value for the crust, which is enriched in refractory elements. Two reversible phase transitions in NWA 6255 bulk's troilite were revealed: α/β transition at (422.9±0.5) K (Fig. 3), an β/γ transition at ~593 K. Enthalpy change for α/β transition was (1.53±0.04) J/g, thus bulk troilite content in NWA 6255 chondrite was calculated to be (3.6±0.1) wt%. The temperature of the troilite transition and the extent of its endothermal effect remains nearly unchanged though the meteorite bulk except the edge part (c.a. 1–2 mm below the surface) and the crust – reduction of temperature (to 422.25±0.7 K and 414.4±3.52 K for egde and for crust, respectively) and significant reduction of transition enthalpy (to 0.50±0.06 J/g and 0.44±0.06 J/g for egde and for crust, respectively) was observed (Tab. 1).

Tab. 1. Temperature of α/β transition, transition enthalpy of samples from different part of NWA 6255 meteorite.

part of meteorite	mass [mg]	$\Delta H_{\alpha/\beta}$ [J/g]	mean $\Delta H_{\alpha/\beta}$ (SD)	$T_{\alpha/\beta}$ [K]	mean $T_{\alpha/\beta}$ (SD)
crust	5.4	0.44	**0.44** (0.06)	410.25*	**414.4** (3.52)
	5.2	0.37		414.15*	
	3.7	0.51		418.85*	
edge	5.5	0.55	**0.50** (0.06)	421.55	**422.25** (0.7)
	6.1	0.44		422.95	
interior	5.7	1.57	**1.53** (0.04)	425.95	**422.9** (0.5)
	5.1	1.49		422.85	

* Peak positions were determined at temperatures between 410 to 418.85 K however, for these samples there was a broad depression indicating two effects of partially oxidized troilite and its α/β transition combined.

Conclusion: Thermal properties of NWA 6255 chondrite are comparable with thermal properties of ordinary chondrites [1–3]. The data obtained for $T_{\alpha/\beta}$ by DSC are in accordance with TL data and the concept of heat gradient in meteoroid envolved during atmospheric passage [4]. DSC is a useful tool which can give us new valuable results in planetary science but more study are needed.

References:
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