Signatures of disorder in the Heat Capacity of Nd-doped LAO laser materials

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Abstract

We present low-temperature specific heat (Cp) of novel class of glass-ceramic materials prepared by aerodynamic levitation method and subsequent heat treatment. The proposed method allowed to obtain a uniquely patterned structure of amorphous and crystalline phase [1]. The investigation of thermal property compares two different samples, amorphous and ceramic one. The heat capacity measurements were performed in a wide temperature range in two series, 1st cooling from 25 K down to 1.8 K and 2nd heating from 1.8 K up to room temperature. Thermal relaxation method implemented in the Heat Capacity Option of commercial setup PPMS® was used to determine the heat capacity [2,3].

Results

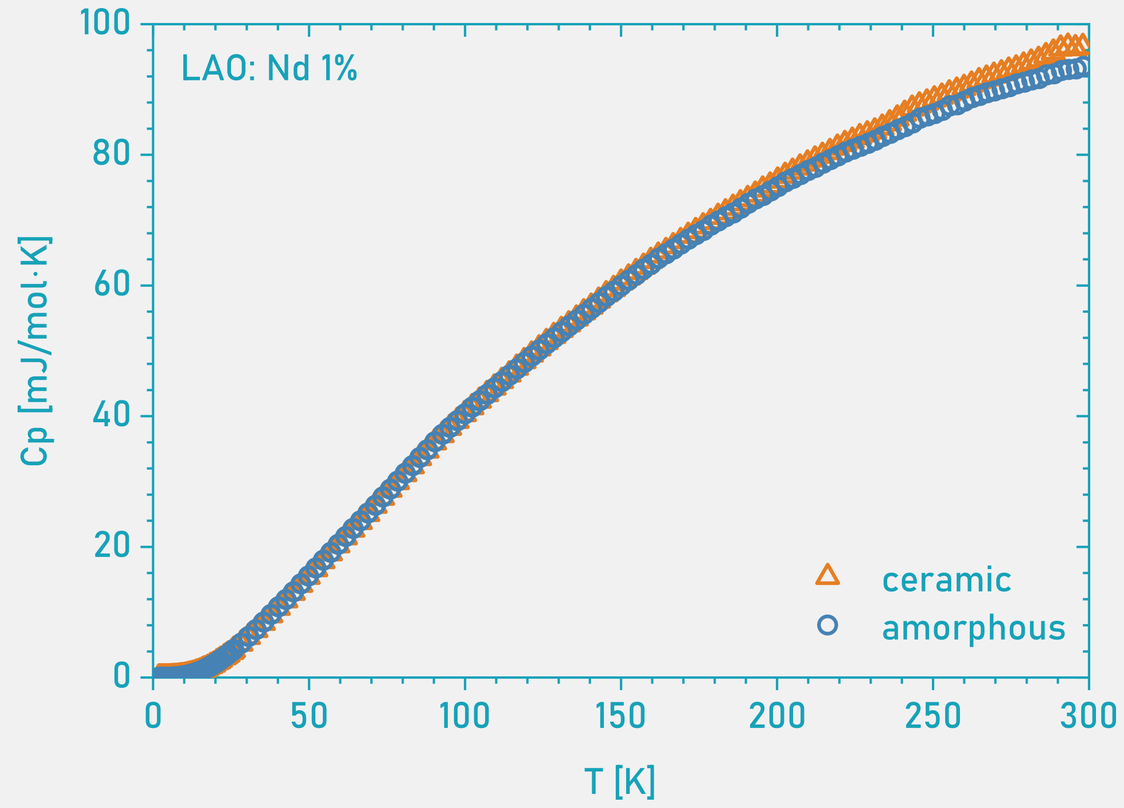

Fig. 1 Specific heat as a function of temperature of glass-ceramic materials at different temperatures.

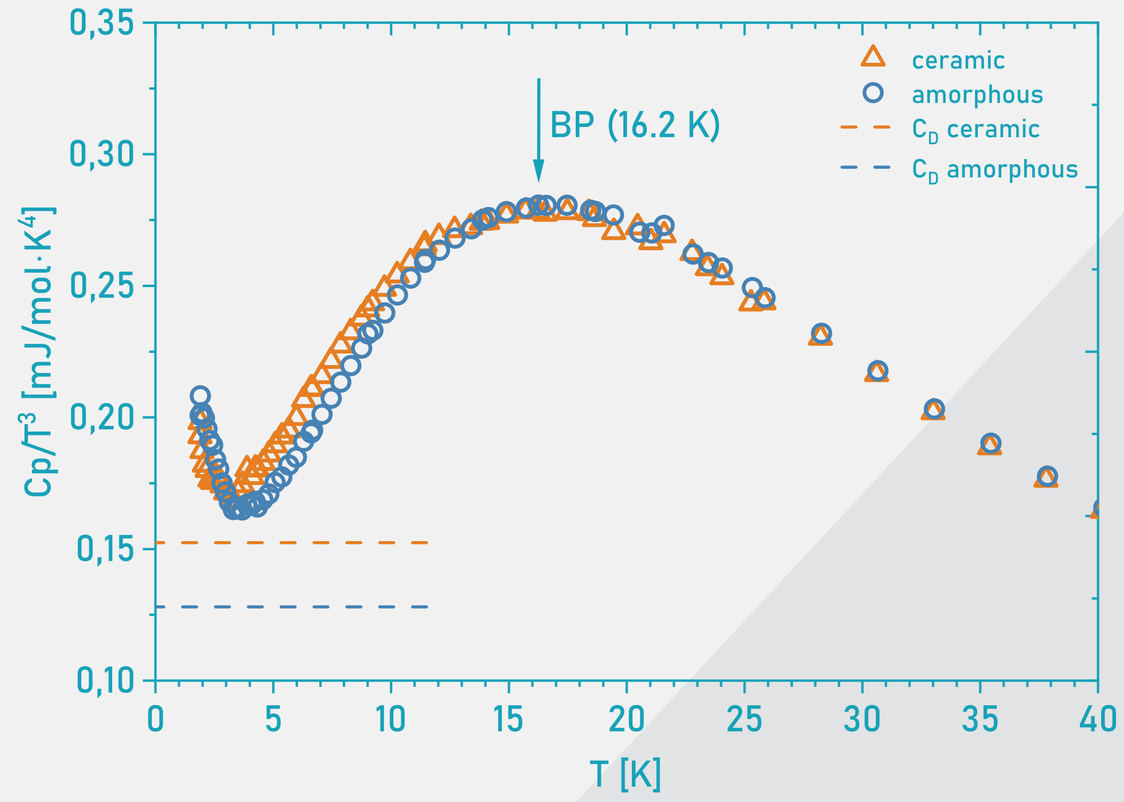

Fig. 2 Low-temperature heat capacity data of samples in a Cp/T^3 representation.

In both cases, the results indicate characteristic features of disordered materials, including a Boson peak near 16 K in the Cp/T^3 vs. T plot and an upturn of Cp/T^3 at low temperatures – connected to presence of tunneling states, shifting slightly depending on the sample. Comparative analysis revealed that the ceramic sample exhibits significantly higher disorder than the amorphous one, as evidenced by the intensity of two-level systems, which is nearly three times greater.

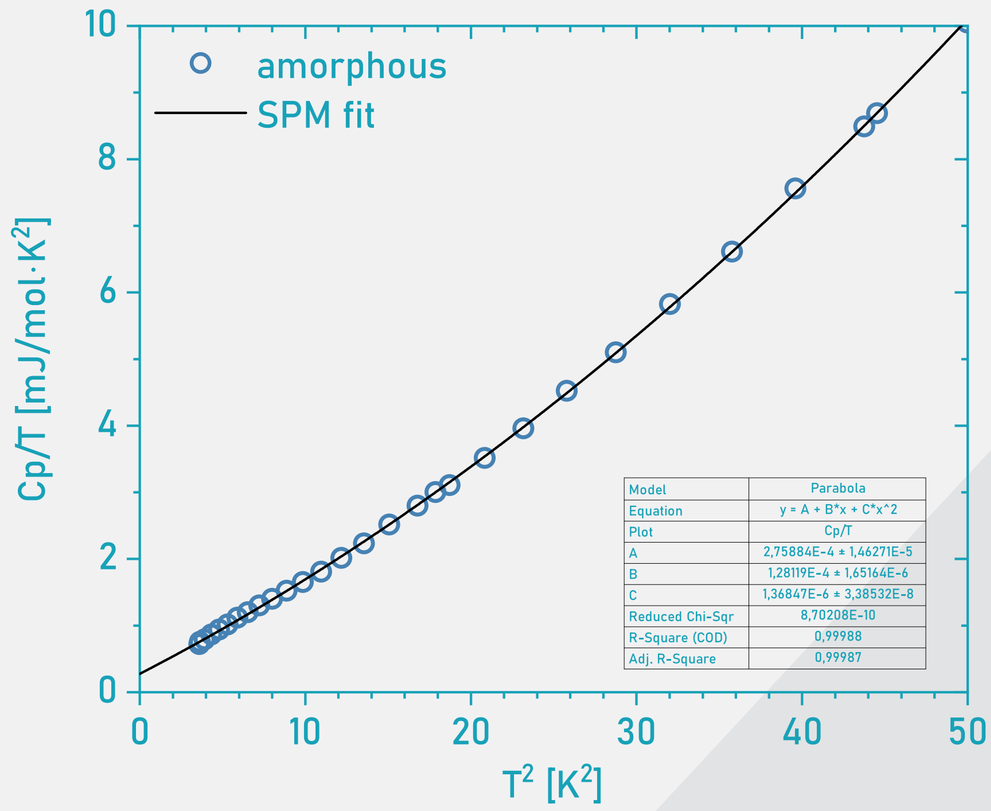

Fig. 3 Low-temperature specific heat in Cp/T representation as a function of square temperature for a amorphous sample.

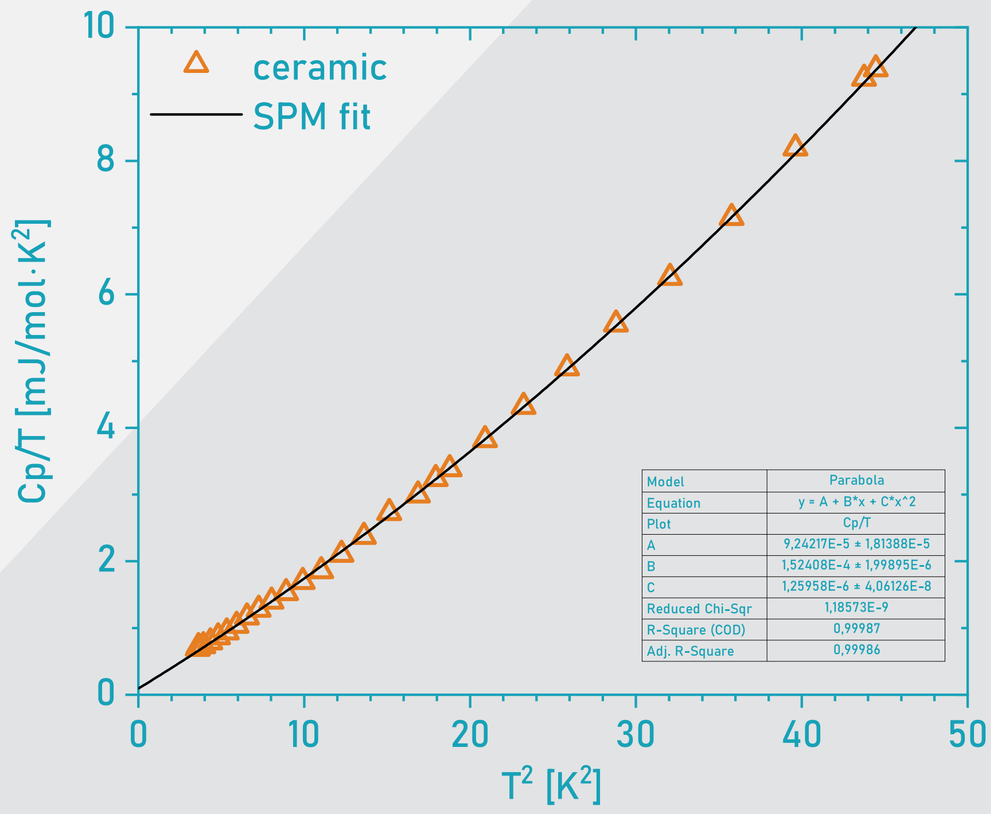

Fig. 4 Low-temperature specific heat in Cp/T representation as a function of square temperature for a ceramic sample.

Parameters of particular amorphous and ceramic phase samples.

Sample	Mass [mg]	C_{TLS} [mJ/mol·K²]	C_{Debye} [mJ/mol·K⁴]	C_{SPM} [mJ/g·K⁴]	θ_D [K]	$\Delta(C_P/T^3)$ @T_{BP} [mJ/g·K⁴]
Amorphous	10,35	0,275	0,128	1,37	423,34	0,153
Ceramic	14,18	0,092	0,152	1,26	399,53	0,126

Acknowledgments

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References

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