DTU Library

Effect of Temperature Step Size on Calculating the Magnetic Entropy Change

Neves Bez, Henrique; Insinga, Andrea Roberto; Nielsen, Kaspar Kirstein; Smith, Anders; Bahl, Christian R.H.

Publication date:
2015

Document Version
Peer reviewed version

Effect of Temperature Step Size on Calculating the Magnetic Entropy Change

Henrique N. Bez, A. R. Insinga, Kaspar K. Nielsen, Anders Smith, Christian R. H. Bahl

DTU Energy Conversion and Storage, Technical University of Denmark,

Frederiksborgvej 399, DK-4000 Roskilde, Denmark

hnbe@dtu.dk

The magnetic entropy change, Δs, is a key parameter in magnetocaloric research. The magnetic entropy change dictates the amount of heat a material may absorb or release upon a magnetic field change. This property may be characterised by indirect[1] or direct methods[2]. One of the indirect methods is the field integration of the derivative of magnetisation with respect to temperature. This calculation is based on a Maxwell relation $(\mathrm{d}s/\mathrm{d}H)_T = (\mathrm{d}M/\mathrm{d}T)_H$, where s, H, T and M, are entropy, magnetic field, temperature and magnetisation, respectively. However, due to the finite resolution of temperature and field in real experiments, this calculation will rely on a numerical approximation, which gives the equation $\Delta s(T_j,\Delta H_i) = \mu_0 \, \Sigma_i \, (M(T_{j+1},H_i) - M(T_{j-1},H_i)) \, / \, (T_{j+1} - T_{j-1}) \, \Delta H_i$, where μ_0 is the vacuum permeability. We have observed, in recent publications, e.g. [3,4], the lack of concern for the implications of this approximation. In this context, we study the effect of the temperature step, $\mathrm{d}T = T_{j+1} - T_j$, on the calculated Δs for 3 different materials: Gd, $La_{0.67}Ca_{0.33}MnO_3$ and $La(Fe,Mn,Si)_{13}H_y$. We evaluate it by means of magnetisation measurements at different values of dT. We observe, for $La(Fe,Mn,Si)_{13}H_y$, that with a dT as large as 3.0 K $\Delta s_{max}(T,\Delta H\text{=}0.75\ T)$ may be ~25 % smaller than the one calculated from dT=1.0 K. This effect decreases for materials with smoother transitions, such as $La_{0.67}Ca_{0.33}MnO_3$ and Gd (~11 % and ~0.8 %, respectively), and for increasing fields.

Key Words: Magnetic entropy change, Maxwell relation.

References :

[1] V. K. Pecharsky et al. J.Appl.Phys. 86 (1999) 565.
[2] K. K. Nielsen et al. submitted to Rev. Sci. Instum. (2015).
[3] R. Mondal et al. J. Mag. Mag. Mat. 393 (2015) 376.
[4] Y. Zhang et al. Sci. Rep. 5 (2015) 11010.