A Peltier cells differential calorimeter for the measurement of $c_p(H;T)$ and $\Delta s(H;T)$ of magnetocaloric materials

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Outline

I. Peltier calorimetry in magnetic field

2. Materials

- La(FeCoSi), La(FeMnSi)-H,
- Materials with spin reorientation (low/no hysteresis)
- Heusler alloys (large hysteresis)
- 3. Open issues and conclusions

Isothermal Peltier cell active calorimetry

isothermal Δs

use of Peltier heat to set constant temperature



[Basso-2008, RSI]





Isothermal entropy change with Peltier cell sensors

Peltier cell calorimetry

differential scanning calorimetry (DSC) in magnetic field

room temperature setup (-30 / +80 °C)





In air, heat sensors RMT 5x5 mm

low temperature setup (4K / 350 K)



Oxford cryostat: cold finger in vacuum Micropelt cells (2.5x2.5x0.9mm³)

[Plackowski-2002] Poland [Marcos-2003] Spain [Jeppesen-2008] Denmark



Electromagnet: 2T max

V.Basso et al., Rev. Sci. Instrum (2010)





Calibration

with Sapphire standard



V.Basso et al., Rev. Sci. Instr. (2010)

Peltier cell calorimetry



V.Basso et al., Rev. Sci. Instr. (2010)

La(FeCoSi)₁₃

second order La(Fe_{0.84}Co_{0.08}Si_{0.08})₁₃

c_p(H,T)





V. Basso, INRIM Torino, Italy. A Peltier cell calorimeter for MCE materials. 24 october 2011, Delft NL

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T(H,s)-T(0,s) temperature change



V.Basso, Basics of the magnetocaloric effect", book in preparation (O.Gutfleisch, K.Sandeman eds.) Wiley

La(FeMnSi)₁₃-H

VAC hydrogenated La(FeMnSi)13



K. Morrison, K.G. Sandeman L.F. Cohen, C.P. Sasso V. Basso, A. Barcza, M. Katter, J.D. Moore, K.P. Skokov and O. Gutfleisch Int. J. Refrigeration, submitted

La(FeMnSi)₁₃-H



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Er₂Fe₁₄B





V. Basso, INRIM Torino, Italy. A Peltier cell calorimeter for MCE materials. 24 october 2011, Delft NL

W-type ferrite





M. LoBue, V. Loyau, F. Mazaleyrat, A. Pasko, V. Basso, M. Kupferling, and C. P. Sasso, JAP accepted (MMM2011 Conf)

Heusler alloys



V. Basso, C. P. Sasso, K. P. Skokov, O. Gutfleisch, V.V. Khovaylo, PRB, submitted

Ni53.3Mn20.1Ga26.6



V. Basso, C. P. Sasso, K. P. Skokov, O. Gutfleisch, V.V. Khovaylo, PRB, submitted

Ni₅₀Mn₃₆Co₁Sn₁₃



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Conclusion

advantages of Peltier calorimetry

- I. able to fully characterize the magnetocaloric properties
- 2. appropriate to determine hysteresis and irreversibilities

open issues

I. calibration to repeat periodically (time degradation of the cells - a few % in I2 months periods)

2. good thermal contacts are needed! (problems with powders)

3. finite shape / demagnetizing field

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Thanks for your attention