SRD1000 Superconductive Reference Devices for Accurate Thermometry on the PLTS-2000

HIGHTECH DEVELOPMENT LEIDEN

W.A. Bosch
P.O. Box 691
2300 AR Leiden, The Netherlands

Physikalisch Technische Bundesanstalt

J. Engert
Abbestrasse 2-12
10587 Berlin, Germany

Kamerlingh Onnes Laboratorium
Leiden Institute of Physics

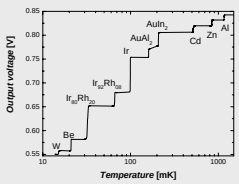
R. Jochemsen, X.Z. Liu
P.O. Box 9504
2300 RA Leiden, The Netherlands

Introduction

- SRD1000 devices support 10 reference temperatures between 10 mK and 1.2 K [1]
- Superconducting to normal transitions of various metallic samples provide stable reference points for thermometry
- Evaluation of prototypes by European metrological institutes proved that the SRD1000 concept is convenient and reliable for transferring the PLTS-2000 [2,3,4], the international ULT scale below 1 K

New SRD1000 pilot production series

- A compact array of planar micro-coils detects the superconductive transitions of the reference samples
- Preparation procedures and attachment techniques for the samples are improved compared to the prototypes series
- A Cryoperm / niobium shield reduces ambient magnetic fields by a factor of 400. The shield has improved thermal properties
- Filters block EM-interference from penetrating the sensor



- The detection electronics supplied with the sensor produces an accurate DC voltage with clearly defined steps at the reference points independent of the experimental set-up
- Measurements show an improved quality of the reference points at 15 mK, 21 mK, 520 mK and 850 mK compared to the prototype series [5]

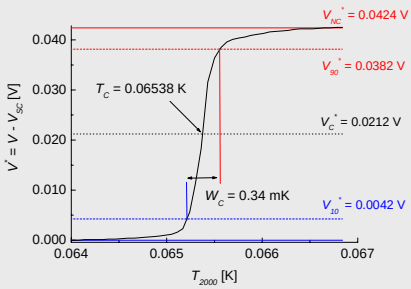
Typical values of the reference points

#	material	T_C [mK]	W_C [mK]	U_C [mK]
1	W	15	< 0.2	< 0.04
2	Be	21	< 0.3	< 0.06
3	$Ir_{80}Rh_{20}$	30	< 0.5	< 0.1
4	$Ir_{92}Rh_{08}$	65	< 0.5	< 0.1
5	Ir	98	< 0.5	< 0.1
6	$AuAl_2$	145	< 0.5	< 0.1
7	$AuIn_2$	208	< 1	< 0.2
8	Cd	520	< 3	< 0.6
9	Zn	850	< 3	< 0.6
10	Al	1180	< 4	< 0.8

T_C = temperature of the superconductive transition
W_C = transition width (temperature interval in which the signal of the transition changes by 80%)
U_C = estimate of the uncertainty in determining T_C related to the characteristics of the transition

Calibration of the reference points

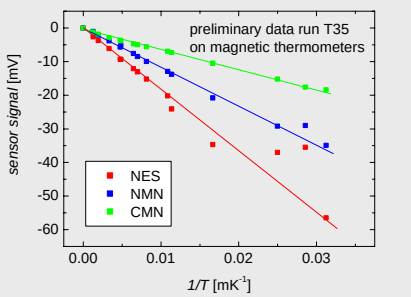
- PTB (the national metrology institute of Germany) calibrates the SRD1000 devices with the highest accuracy and reliability
- The calibration allows accurate transfer of the PLTS-2000 to the ultra-low temperature community
- Calibrated devices are commercially available through HDL



Example of a calibrated reference point at 65mK (superconductive transition of an $Ir_{92}Rh_{08}$ sample); the calibration parameters of the transition are indicated

Magnetic thermometer option

- A magnetic thermometer integrated with the SRD1000 sensor allows interpolation between the reference points
- Possible candidates (depending on the temperature range) are paramagnetic salts, for example powdered NES, NMN or CMN



Preliminary results of measurements on the magnetic signal of some paramagnetic salts versus 1/T (the sensor signal is proportional to the susceptibility of the material)

Further developments

- To integrate the magnetic thermometer option with the technology for detecting the reference points
- To increase the number of supporting points for the PLTS-2000 with a Mo reference point at 950 mK and a Ti point at 300 mK

References

1. W.A. Bosch et al., in *Temperature: Its Measurement and Control in Science and Industry* 7, 155-160 (2003), edited by D.C. Ripple, AIP, New York.
2. R. Rusby et al., *J. Low Temp. Phys.*126, 633 (2002).
3. A. Peruzzi et al., *Proc. of TEMPMEKO2004,* (to appear).
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Further information

E-mail: *HDLinfo@xs4all.nl*
Web page: *http://www.xs4all.nl/~hdleiden/srd1000*