SRD1000 measurement systems *for precision thermometry on the PLTS-2000*

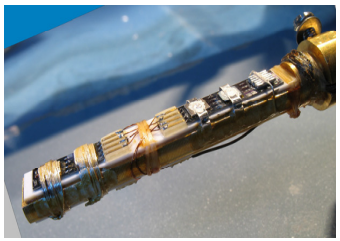
HDL, the company

- A one-man business founded by Wim Bosch in 1996
- Core business: development and sales of cryogenic special products in cooperation with other companies and institutes
- More than 30 years of experience in low temperature physics and related instrumentation
- Main product is the SRD1000 measurement system for precision thermometry on the PLTS-2000, the international ULT- scale below 1 K [1]

HDL workshop

SRD1000 superconductive reference device

- Device supports 10 reference temperatures between 10 mK and 1.2 K [2]
- Superconductive to normal transitions of samples of various materials provide stable reference points for thermometry
- A compact array of planar micro-coils detects the transitions
- A Cryoperm / niobium shield reduces ambient magnetic fields by a factor of 400
- Filters suppress the effects of RF-interference



Detector array with reference samples

Development of the SRD1000 technology

2000 - 2003
- A Dutch consortium - comprising HDL, NMi-VSL (the national metrology institute), Leiden University and the University of Twente - develops a series of 5 prototypes of SRD1000 devices and electronics
- Evaluation by various metrological institutes in Europe [3] proves that the concept is reliable for transferring the PLTS-2000

2003 - 2006
- Development of a pilot series with improved sensor characteristics [4]
- Several systems are calibrated at PTB (the national metrology institute of Germany - web site: http://www.ptb.de) and sold to institutes in Europe and Japan

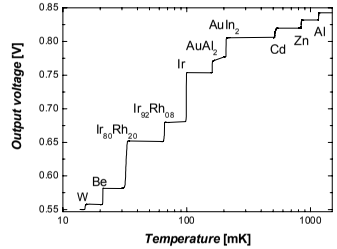
2006 - 2008
- Development of a production series
- Integration of the SRD sensor and a CMN (Cerium Magnesium Nitrate) paramagnetic susceptibility thermometer for continuous thermometry (range < 10 mK and 1 K)
- New detection electronics for simultaneous measurements of the SRD and CMN signals provides in-situ calibration of the CMN thermometer [5]

SRD1000 measurement system

- The SRD1000 measurement system comprises the SRD1000 device and detection electronics (MIDS-20x series)
- The electronics is essential for reliable realisation of the calibrated reference temperatures of the device

MIDS-202 detection electronics

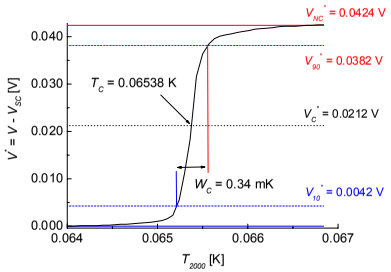
Output voltage of the electronics versus sensor temperature showing the 10 transition points of the device



Typical values of the SRD1000 reference points

#	material	T_C [mK]	W_C [mK]	U_C [%]
1	W	15	< 0.2	< 0.26
2	Be	21	< 0.3	< 0.28
3	$Ir_{80}Rh_{20}$	30	< 0.5	< 0.34
4	$Ir_{92}Rh_{08}$	65	< 0.5	< 0.16
5	Ir	98	< 0.5	< 0.10
6	$AuAl_2$	145	< 0.5	< 0.06
7	$AuIn_2$	208	< 1	< 0.10
8	Cd	520	< 4	< 0.16
9	Zn	850	< 3	< 0.08
10	Al	1180	< 4	< 0.06

with:
T_C = *transition temperature reference material*
W_C = *transition width (temperature interval in which the signal of the transition changes by 80%)*
U_C = *relative uncertainty in determining T_C, related to 0.1*W_C*



Example of the $Ir_{92}Rh_{08}$ transition and its V, T calibration parameters; PLTS-2000 calibration by PTB

References

[1] R. Rusby et. al., J. Low Temp. Phys. 126, 633 (2002)
[2] W.A. Bosch et. at. in Temperature Its Measurement and Control in Science and Industry **7,** 155-160 (2003), edited by C. Ripple, AIP, New York
[3] S. Schöttle et. al., J. Low Temp. Phys. 138, 941 (2005)
[4] W.A. Bosch et. al., AIP Conference Proceedings, LT24, Volume 850, pp. 1589-1590 (2006)
[5] A. Peruzzi et. al., J. of Phys., Conference Series, Proceedings LT25 (2009)

Further information

HDL
P.O. Box 691
2300 AR Leiden
The Netherlands

Web site: *http://www.xs4all.nl/~hdleiden/srd1000*
Contact: Wim Bosch
E-mail: *HDLinfo@xs4all.nl*

Distributor in Japan
ROCKGATE Corporation
Web site: *http://www.rockgateco.com*
Contact: Tsuneo Kado
E-mail: *kado@rockgateco.com*