

Realizing the redefined kelvin: thermodynamic temperatures of Fe-C, Pd-C, Ru-C and WC-C for the mise-en-pratique of the kelvin up to 3020 K

M. SADLI¹, F. BOURSON¹, D. LOWE², K. ANHALT³, D. TAUBERT³, M.J. MARTIN⁴, J.M. MANTILLA⁴, F. GIRARD⁵, M. FLORIO⁵, C. GÖZÖNÜNDE⁶, H. NASIBLI⁶, L. KŇAZOVICKÁ⁷, N. SASAJIMA⁸, X. LU⁹, O. KOZLOVA¹, S. BRIAUDEAU¹, G. MACHIN²

¹LNE-Cnam, Laboratoire commun de métrologie, Saint-Denis, France ²NPL, National Physical Laboratory, Teddington, United-Kingdom ³PTB, Physikalisch-Technische Bundesanstalt, Berlin, Germany ⁴CEM, Centro Español de Metrología, Tres Cantos, Spain ⁵INRIM, Istituto Nazionale di Ricerca Metrologica, Torino, Italy ⁶TUBITAK-UME, Ulusal Metroloji Enstitüsü, Gebze, Türkiye ⁷CMI, Czech Metrology Institute, Brno, Czech Republic ⁸NMIJ, National Metrology Institute of Japan, Tsukuba, Japan ⁹NIM, National Institute of Metrology, Beijing, People's Republic of China

Corresponding Author: mohamed.sadli@lecnam.net

MS ORCID: 0000-0001-8792-4115, GM ORCID: 0000-0002-8864-6951, KA ORCID: 0000-0003-0021-0641, FB ORCID: 0000-0003-2526-3280, MJM ORCID: 0000-0002-3970-3470, NS ORCID: 0000-0002-2397-8947, XL ORCID: 0000-0002-1090-2046, OK ORCID: 0000-0002-5974-0228, SB ORCID: 0000-0001-7160-4264,

The *Mise-en-Pratique* for the definition of the kelvin at high temperatures has opened the possibility of disseminating thermodynamic temperature through relative primary radiometry mediated through high-temperature fixed points (HTFPs). The thermodynamic temperatures of Co-C, Pt-C and Re-C [1] were determined under the auspices of the Euramet joint research project InK [2]. Here we report on efforts to determine the thermodynamic temperature of the phase transition of four more HTFPs, namely, Fe-C ~1426 K, Pd-C ~1765 K, Ru-C ~2227 K and WC-C ~3020 K as part of the European research project Real-K [3].

During this three-year project (ending April 2023) participants from nine countries (some beyond Europe) have contributed to this endeavour by a) supplying HTFP cells b) selecting the best cells for thermodynamic temperature assignment c) performing direct or relative thermodynamic temperature measurements on the circulating cells and d) comparing the cells for drift analysis.

This presentation gives an overview of the experimental activities performed during the project and summarizes the results of the thermodynamic temperature assignment. In fig1, the reported provisional thermodynamic temperatures of the point of inflection (poi) are shown for the WC-C point. The agreement between the participants is noticeably good and the weighted mean temperature has been determined collectively with an expanded uncertainty of 0.25 K thanks to the independent determinations at 6 different institutes.

Finally, after two decades of research and cooperation a series of seven HTFPs with assigned thermodynamic temperatures will soon be available for the realization of the kelvin and its dissemination.

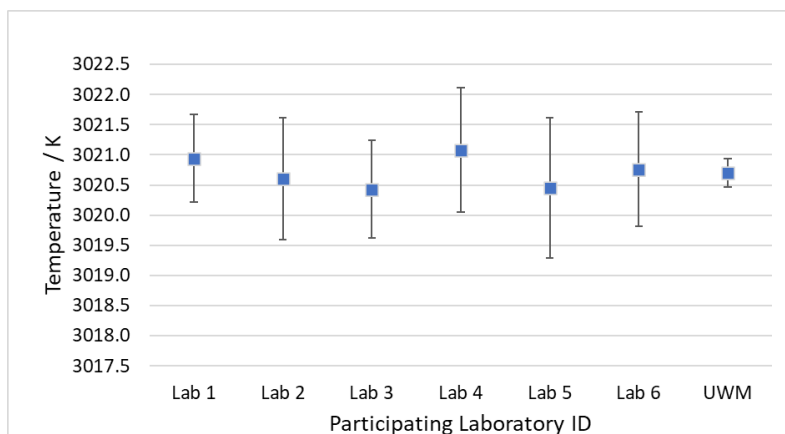


Fig. 1. Reported point-of-inflection thermodynamic temperatures and uncertainties ($k=2$) from participating laboratories, compared to the uncertainty-weighted mean (UWM) with its uncertainty (including thermal effects)

References

- [1] D H Lowe *et al* 2017 *Metrologia* **54**, 390
- [2] G Machin *et al* 2016 *Measurement* **94**, p149–156
- [3] G Machin *et al* 2022 *Measurement* **201**, 111725