CCT member and observer Activity Report

Period: January 2017 to December 2021

Institute: NMIJ/AIST

State economy: APMP

Number of persons involved in thermometry of the institute:

Short summary of research and development:

Contact thermometry

·Evaluation of T-T_{90} between TPW to the melting point Ga using acoustic thermometry [C2, C3]

·Development of low temperature thermometers and investigation of long term stability and non-uniqueness of SPRTs below TPW [C5, C14]

·Realization of the triple point of mercury and observation of its large supercooling [C9]

·Evaluation of the temperature of the triple points of SF_6 and CO_2 as alternative candidates to the triple point of mercury for the fixed point of the ITS-90 [C1, C6, C7]

·Development of high temperature SPRT up to the freezing point of Ag [C8, C15]

·Development of metal-carbon eutectic fixed points for calibration of thermocouples [C16]

·Development of calibration apparatus for the contact surface thermometers [C4, C17]

Non-contact thermometry

·Development of high emissivity microcavity type blackbody sheet and flat-plate reference radiator [R1, R3, R6, R7].

·Research for improving the reliability of non-contact body temperature measurement [R1, R3, R6].

·Research on the Optical frequency comb thermometry [R2, R11].

·Research on the radiometric temperature measurement by incoherent digital holography [R8, R10].

·Performance evaluation of high-temperature fixed points [R4, R5, R9, R13].

·Research on radiation thermometry [R12].

Humidity

·Development of trace-moisture analyser based on cavity ring-down spectroscopy [H1, H3, H6, H8].

·Participation of key comparison [H2, H5].

·Development of primary-trace moisture standard [H4, H9].

·Improvement of primary high-humidity standard generator [H7].

Thermophysical quantities

·Development of measurement techniques for Thermophysical quantities [T1-T6]

·Supply of certified reference material (CRM) for thermophysical quantities [T7-T9]

Short summary of recent comparison activity:

Contact thermometry

·Lead APMP.T-K7.1 [C11], participating CCT-K1.1, CCT-K4.1, CCT-K9, APMP.T-K9, CCT-K7.2021.

Non-contact thermometry

·Lead APMP. T-S11, T-S12, APMP TCI project [R9], participation in CCT-K10, APMP. T-S15, EMPIR project "Implementing the new kelvin" [R13].

Humidity

·Lead APMP. T-K8 [H2], participation in CCT-K8, APMP.T-K6:2013, APMP.T-S14, and APMP.T-17.

Thermophysical quantities

·Lead APMP. T-S9, T-S10, CCT-S3(Thermal Diffusivity)

Link to bibliography or list of bibliography (last 5 years):

[C1] Y. Kawamura and T. Nakano, "Evaluation of the temperature scale of SPRT calibrated at the triple point of sulfur hexafluoride", Measurement: Sensors (2021) 18 100211

[C2] J. V. Widiatmo, T. Misawa, T. Nakano, I. Saito, "Preliminary measurements of T-T_{90} using acoustic gas thermometer in neon gas", Measurement: Sensors (2021) 18 100191

[C3] J. V. Widiatmo, T. Misawa, T. Nakano, I. Saito, "Thermodynamic Temperature Measurements from the Triple Point of Water up to the Melting Point of Gallium", Int J Thermophys (2020) 41:42

[C4] I. Saito, T. Nakano, H. Ogura, J. Tamba, Y. Mizukado, S. Kobayashi, "Estimation of environmental effects on performance of contact surface thermometers using a calibration apparatus", Meas Sci Technol (2020) 31: 104004

[C5] T. Nakano, Y. Kawamura, T. Imamura, N. Imamura, K. Kinoshita, "ITS-90 non-uniqueness and evaluation of characteristics of new 1000 Ω type platinum resistance thermometers for low-temperature measurement", Meas Sci Technol (2020) 31:094017

[C6] Y. Kawamura and T. Nakano, “Evaluation of the triple point temperature of sulfur hexafluoride and the associated uncertainty at NMIJ/AIST”, Metrologia (2020) 57:014003

[C7] Y. Kawamura, N. Matsumoto and T. Nakano, “Realization of the triple point of carbon dioxide evaluated by the ITS–90”, Metrologia (2020) 57:015004

[C8] J. V. Widiatmo, Ikuhiko Saito, Tohru Nakano, “Evaluation of High‐Temperature Platinum Resistance Thermometers Based on ITS‐90”, Int J Thermophys (2020) 41:40

[C9] Y. Kawamura, I. Saito and T. Nakano, “Realization of the Triple Point of Hg and Observation of a Large Supercooling Using Small Glass Cell”, Int J Thermophys (2019) 40:76

[C10] P. P. M. Steur, I. Yang, S. Kim, T. Nakano, K. Nagao, F. Pavese, “An inter-comparison of isotopic composition of neon via chemical assays and thermal analyses”, Pure Appl. Chem. (2019) 91:1869

[C11] K. Yamazawa, T. Nakano, P. T. Binh, “Final report on APMP. T-K7. 1 key comparison of water triple point cells, bilateral NMIJ-VMI”, Metrologia (2018) 55: 03002

[C12] T. Nakano, “Uncertainty estimation for extrapolation of the ITS-90 down to the boiling point of nitrogen from the triple point of argon”, J Phys Conf Ser (2018) 1065: 122025

[C13] T. Misawa, J. V. Widiatmo, Y. Kano, T. Sasagawa, K. Yamazawa, “Progress Report on NMIJ Acoustic Gas Thermometry at the Triple Point of Water”, Int J Thermophys (2018) 39:4

[C14] T. Nakano, “Stability of Standard Platinum Resistance Thermometers and Rhodium Iron Resistance Thermometers for the Past Decade in NMIJ/AIST”, Int J Thermophys (2017) 38:63

[C15] Y. Tanaka J. V. Widiatmo, K. Harada, T. Kobayashi, K. Yamazawa, “A Challenge to Improve High-Temperature Platinum Resistance Thermometer”, Int J Thermophys (2017) 38:76

[C16] H. Ogura, F. Jarhan, K. Yamazawa, “Comparisons of Co–C and Pd–C Eutectic-Point Cells for Thermocouple Calibration Between NMIA and NMIJ”, Int J Thermophys (2017) 38:27

[C17] I. Saito, T. Nakano, J. Tamba, “Estimating Surface Temperature of a Calibration Apparatus for Contact Surface Thermometers from Its Internal Temperature Profile”, Int J Thermophys (2017) 38: 156

[C18] T. Nakano, T. Shimazaki, O. Tamura, “Reproducibility of the Helium-3 Constant-Volume Gas Thermometry and New Data Down to 1.9 K at NMIJ/AIST”, Int J Thermophys (2017) 38:105

[C19] S. Baba, K. Yamazawa, T. Nakano, I. Saito, J. Tamba, T. Wakimoto and K. Katoh, “Development of a 300 L Calibration Bath for Oceanographic Thermometers”, Int J Thermophys (2017) 38:164

[C20] J. V. Widiatmo, I. Saito, K. Yamazawa, “Construction of Gallium Point at NMIJ”, Int J Thermophys (2017) 38:42

[C21] J. V. Widiatmo, S. Rudtsch, K. Yamazawa, “Progress Report on the Cooperation Between NMIJ and PTB on Zinc Point Cells”, Int J Thermophys (2017) 38:65

[R1] Y. Shimizu, H. Koshikawa, M. Imbe, T. Yamaki, K. Godo, N. Sasajima, and K. Amemiya, "Micro-cavity perfect blackbody composite with good heat transfer towards a flat-plate reference radiation source for thermal imagers", Opt. Lett. 46, (2021) 4871.

[R2] T Irimatsugawa, Y Shimizu, S Okubo, H Inaba, “Cosine similarity for quantitatively evaluating the degree of change in an optical frequency comb spectra”, Opt. Express, 29 (2021) 35613.

[R3] K. Amemiya,Y. Shimizu, N. Sasajima, M. Imbe, and K. Godo, "Reliability enhancement of non-contact fever screening technology (thermography, etc.) for quarantine inspection", Measurement: Sensors 18 (2021) 100160.

[R4] A D W Todd, K Anhalt, P Bloembergen, B B Khlevnoy, D H Lowe, G Machin, M Sadli, N Sasajima, and P Saunders, “On the uncertainties in the realization of the kelvin based on thermodynamic temperatures of high-temperature fixed-point cells”, Metrologia 58 (2021) 035007.

[R5] Y Yamada, “Investigation on the cause of the furnace effect of high-temperature fixed points”, Meas. Sci. Technol. 32 (2021) 015009.

[R6] Y. Shimizu, H. Koshikawa, M. Imbe, T. Yamaki, and K. Amemiya, "Large-area perfect blackbody sheets having aperiodic array of surface micro-cavities for high-precision thermal imager calibration", Opt. Express 28, (2020) 22606.

[R7] K. Amemiya, H. Koshikawa, M. Imbe, T. Yamaki, and H. Shitomi, "Perfect blackbody sheets from nano-precision microtextured elastomers for light and thermal radiation management", J. Mater. Chem. C 7, (2019) 5418–5425.

[R8] M. Imbe, "Radiometric temperature measurement by incoherent digital holography," Appl. Opt. 58 (2019) A82–A89.

[R9] N. Sasajima, X. Lu, B. Khlevnoy, I. Grigoryeva, Y. S. Yoo, D. Otryaskin, S. Markin, T. Wang and Y. Yamada, "Performance of WC–C peritectic and Ru–C eutectic fixed points", Metrologia 56 (2019) 055010.

[R10] M. Imbe, "Optical configuration with fixed transverse magnification for self-interference incoherent digital holography," Appl. Opt. 57 (2018) 2268–2276.

[R11] Y. Shimizu, S. Okubo, A. Onae, Koichi, M. T. Yamada, and Hajime Inaba, "Molecular gas thermometry on acetylene using dual-comb spectroscopy: analysis of rotational energy distribution", Appl. Phys. B 124 (2018) 71.

[R12] Y. Yamaguchi and Y. Yamada, "Thermodynamic temperature measurement to the indium point based on radiance comparison," International Journal of Thermophysics 38 (2017) 49.

[R13] D. H. Lowe, N. Sasajima, Y. Yamada, Y. Yamaguchi, et al, "The equilibrium liquidus temperatures of rhenium-carbon, platinum-carbon and cobalt-carbon eutectic alloys", Metrologia 54 (2017) 390–398.

[H1] Koji Hashiguchi, Daniel Lisak, Agata Cygan, Roman Ciuryło, Hisashi Abe, Spectral analysis of H2O near 7180 cm–1 to accurately measure trace moisture in N2 gas: Evaluation of line shape profiles using Akaike Information Criterion, Japanese Journal of Applied Physics (in press)

[H2] H Abe, H Kitano, J Lovell-Smith, A Achmadi, C P Cheung, B I Choi, F Hussain, F Jahan, U Norranim, A Sindhu, S-F Tsai, L Wang, Final report on APMP comparison in humidity APMP.T−K8: Dew point temperature +30 °C to +95 °C, Metrologia 58(1A) (2021) 03002-03002.

[H3] H. Abe, K. Hashiguchi, D. Lisak, S. Honda, T. Miyake, H. Shimizu, A miniaturized trace-moisture sensor based on cavity ring-down spectroscopy, Sensors and Actuators A: Physical, 320 (2021) 112559-112559.

[H4] M. Amano, H Abe, Development of a primary measurement standard of trace moisture in Ar, Metrologia 58 (2021) 015001 .

[H5] C. Meyer, H. Abe, Bilateral key comparison CCT-K6.2 on humidity standards in the frost-point temperature range from −80 °C to −30 °C, Metrologia, 57 (2020) 03007.

[H6] K. Hashiguchi, D. Lisak, A. Cygan, R. Ciuryło, H. Abe, Parts-per-trillion sensitivity for trace-moisture detection using wavelength-meter controlled cavity ring-down spectroscopy, AIP Advances 9 (2019) 125331.

[H7] N. Ishiwata, T. Niwa, H. Abe, Accurate and precise dew-point control system based on active pressure control in two-pressure humidity generator, Rev. Sci. Instrum. 90 (2019) 076104.

[H8] H. Abe, K. Hashiguchi, D. Lisak, Dual-laser cavity ring-down spectroscopy for real-time long-term measurement of trace moisture in gas, Meas. Sci. Technol. 30 (2019) 015002.

[H9] M. Amano and H. Abe, Gas dilution system using critical flow Venturi nozzles for generating primary trace-moisture standards in multiple gas species, Meas. Sci. Technol. 28 (2017) 025007.

[T1] M. Akoshima, S. Takahashi, ”Anisotropic Thermal Diffusivities of Plasma-Sprayed Thermal Barrier Coatings’, Int. J. Thermophysics 38 (2017) 134-1;134-12.

[T2] Y. Yuanru, H. Watanabe et. Al, ”High Temperature Thermal Diffusivity Measurement for FeO Scale by Electrical-Optical Hybrid Pulse-Heating Method”, ISIJ INTERNATIONAL 61-1 (2018)2186;2190.

[T3] A. Hasegawa, T. Yagi and K. Ohta, “Combination of pulsed light heating thermoreflectance and laser-heated diamond anvil cell for in-situ high pressure-temperature thermal diffusivity measurements”, REV. OF SCI. INSTRUMENTS 90 (2019)74901.

[T4] H. Watanabe, K. Morimoto et. al., ”Multi-stepwise pulse calorimetry for accurate, efficient measurements of thermophysical properties over a wide temperature range”, THERMOCHIMICA ACTA 693 (2020)178763-1:178763-6.

[T5] M. Li, M. Akoshima, “Appropriate metallic coating for thermal diffusivity measurement of nonopaque materials with laser flash method and its effect”, International Journal of Heat and Mass Transfer 148 (2020) 119017.

[T6] M. Akoshima, “Development of an apparatus for practical calibration of heat flux sensors”, Measurement: Sensors, 18 (2021) 100343.

[T7] https://unit.aist.go.jp/nmij/english/refmate/

[T8] H. Abe, “National Standard and New Reference Material for Specific Heat Capacity Measurements”, ANALYTICAL SCIENCES 37 (2021) 201.

[T9] M. Li, M. Akoshima, N. Yamada, “Development of quartz glass as a certified reference material for thermal diffusivity measurements”, International Journal of Thermal Sciences 165 (2021) 106955.