



TC Thermometry Activities and highlights

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Madrid and Tres Cantos, Spain
15 – 18 May 2017



Agenda



- Introduction to TC-T
- Annual meeting, technical and engagement workshops
- Highlights for TC-T community
 - Tempmeko 2016
 - New kelvin projects (more in 2018)
- Impact of reliable Humidity and moisture measurement
- Plans for 2017 - 2018



Thermometry

Introduction to TC-T



Thermometry

Introduction to the TC-T



- Main field – thermometry (NPL)
- Sub committee on humidity (INRIM, [LMK vice convenor])
- Working groups on
 - Cmc review (NPL)
 - Strategy (CEM)
 - Best practice and guides (SMD)
 - Thermophysical quantities (CNAM-LNE [SMU])



Thermometry

TC-T 2017, Annual meeting, technical and engagement workshops

A large, stylized number "3" is formed by a dense collection of small, multi-colored dots in shades of blue, orange, yellow, and purple. The dots are arranged to create a sense of depth and movement, with the number appearing to be composed of many individual points.

Thermometry

Annual meeting: 25-28 April 2017



Hosted by CEM, Madrid – around 70 delegates



- Next meeting: 24-27 April 2018, RISE, Sweden



Thermometry

Two 0.5 day workshops prior to TC-T plenary



- Technical workshop – air temperature measurement
 - Organised by Stephanie Bell (NPL) and Davor Zvizdic (FSB)
 - 5 presentations + active contact person involvement
 - Led to formation of TC-T TG on air temperature measurement
- Engagement workshop
 - TG convenors, CB and STAIR coordinators short presentations
 - Contact person discussions about strengthening engagement with TGs, CB, STAIR
- 2018 technical workshops; on thermal imaging, ice & sea temperature measurement



Thermometry

Highlights for TC-T community

- Tempmeko 2016
- New kelvin projects (more in 2018)



Thermometry



TEMPMEKO 2016

Zakopane, Poland



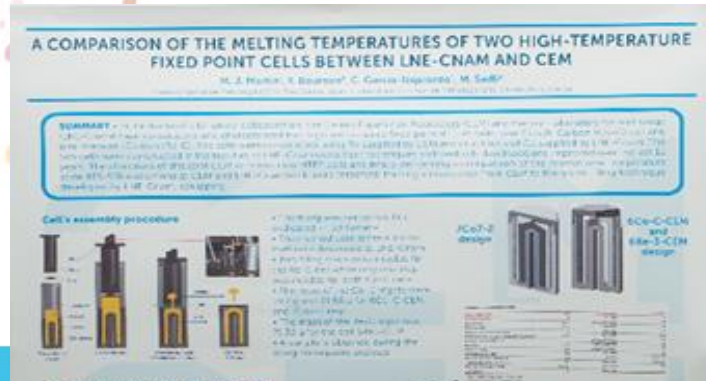
Wł. Trzebiatowski Institute
of Low Temperature and Structure Research
of the Polish Academy of Sciences



Thermometry



- y 2016
- International Programme C
and applications: tempera
re, thermophysical quan
y, medicine.....
m 46 countries
ons, >180 posters



The two Implementing the new kelvin (InK) projects

- Together cover the temperature range $\sim 1\text{mK}$ to 3000 K
- Objective
- EMRP: InK-1 Sep 2012 – Oct 2015
- EMPIR: InK-2 Jun 2016 – May 2019
- Strong cooperation between Euramet and ex-EU NMIs – *essential* to lead the world thermometry community to implement a successful redefinition
- *Realisation phase* post implementation after May '19

Most major institutes in the world in primary thermometry are contributing to the InK activity



- Key activities

Primary thermometry (complete primary temperature evaluation from 0.0009 K to ~3000 K for MeP-K-19)

- $T-T_{90}$

- ~300 K – 1358 K: high temperature acoustic thermometry and low temperature primary radiometry
 - ~1 K – 200 K: acoustic thermometry, dielectric constant gas thermometry, refractive index thermometry

- $T-T_{2000}$

- T from 0.02 K to 0.0009 K, completing full $T-T_{2000}$ evaluation
 - Practical primary thermometers for direct T dissemination (<1 K)

Dissemination

- CCT workshop 2019, definitive contributions to MeP-K-19
 - Including worlds lowest uncertainty $T-T_{90}$ and $T-T_{2000}$

Impact of reliable humidity and moisture measurement

(thanks to Vito Farnicola (INRIM) and Doman Hudoklin (LMK))



Thermometry

- Humidity and moisture metrology challenges
 - Challenges related to standards
 - Emerging metrology requirements
 - Applications
- Across four main measurement areas
 - Relative humidity measurements
 - Dew / frost point measurements (e.g. energy gases)
 - Moisture measurements (in materials)
 - Water activity measurements (e.g. pharma and food)



Challenges related to Standards



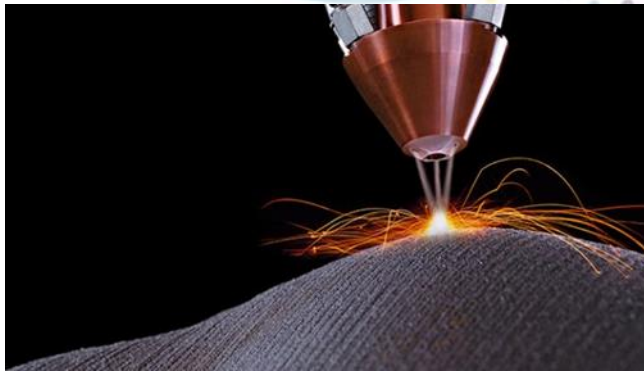
- Definition of relative humidity in terms of fundamental thermodynamics quantities (relative fugacity, atomic and molecular interactions etc.)
- Harmonization of the existing measurement methods, and of improved standards, effectively tying them to SI
- Robust SI-tied traceability of water activity to a bulk properties (water mass fraction)
- More robust measurement uncertainties



- Relative humidity measurements
- Data on the effect of the operating conditions on sensors (e.g., hysteresis, drift)
- Humidity realisations at low pressure (< 200 mbar) and low temperature (below -40°C)
- Dynamic behaviour of sensors under transient conditions



- Relative humidity measurements
 - Robust and stable process sensors for harsh industrial environments (metallurgy, drying, baking, etc.)
 - Accurate upper air humidity (and temperature) measurements for climate and meteorology research



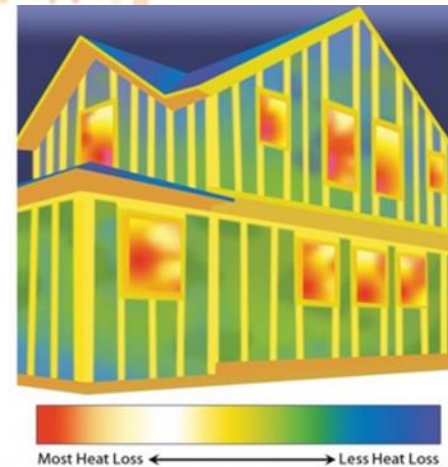
- Moisture in materials
 - Primary realisations for water mass fraction and amount fraction
 - Development of new certified reference materials (CRMs)
 - Improvement in gravimetric, coulometric and KF measurements
 - lack of robust traceability



Applications



- Moisture in materials
 - Pharmaceutical and food industry (product manufacture, packaging, storage)
 - Moisture content monitoring and control for bio-refineries and bio-fuel production
 - Energy performance of buildings



Thermometry

Plans for 2017 - 2018



Plans for 2017 - 2018



- Begin transition to new chair – Q3 '17
- Preparation of new JRPs; e.g. Industrial thermometry
Progress towards the redefined kelvin
 - CCT (31 May - 2 June 2017), InK 2
- Begin planning for EMPIR 2018 e.g. realisation of redefined kelvin “Real-K”, PRT in SI broader scope?
- Capacity Building: Training
 - Proposed 2018 Summer School for next generation of thermal metrologists – “rolling participation”
- Implementing KCDB 2.0 ...
- Revision of TC-T area roadmaps mid '18 – to link with the coordination strategy



Thermometry

- Dew/frost point temperature measurements
 - Humidity realisation in different carrier gases (e.g. H_2 , CO_2 , CH_4 , SF_6 , etc.) at process pressure and temperature
 - Key comparison of humidity realisations at low (frost point) temperatures (-60° to -100°C)



- Dew/frost point temperature measurements
 - High-purity, contaminant-free, process gases used in the semiconductor industry for microelectronics fabrication
 - Measurement of humidity content in energy-carrier gases (H_2 , CH_4) and in electric power facilities (SF_6)



Thermometry

- Water activity measurements
 - Water activity measurement (ERH) techniques for in-line measurements
 - Dynamic behaviour of sensors under transient conditions
 - Comparison of methods and measurement realizations
 - Advances in heat and mass transfer modelling and sample management (moisture profiles)



- Water activity measurements
 - Pharmaceutical and food industry (in-line measurements and moisture flux)
 - Heat treatment processes involve water transfer detection (baking, drying)
 - Food industry for better correlation between water content and product shelf-life

