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National Standards Technology Advancement

Opportunities for communication and collaboration between National standards laboratories and the calibration community to improve calibration technologies and methodologies

Strengthening the Radiometric Link to the SI: Achievements from the chipSCALe Project

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ABSTRACT: The EURAMET European Metrology Programme for Innovation and Research (EMPIR) project chipS·CALe aims to improve and simplify radiometric traceability with a focus on strengthening the link between radiometric measurements and the international system of units (SI). In this project, several national metrology institutes (NMIs) and research institutions in Europe have collaborated to develop improved low-loss Predictable Quantum Efficient Detector (PQED) photodiodes with an external quantum deficiency in the 10 ppm range or below from 400 nm to 850 nm.

These induced-junction photodiodes are simple in their structure, making them suitable for 3D computer simulations. In a 2 minute animation video developed in the chipS·CALe project, we will show the photodiode structure, the working principle, and how to use simple I-V measurements combined with a 3D model fit to extract photodiode defining loss parameters. Once the parameters are known, the fitted model is used to predict the responsivity of the photodiode in the spectral range from 400 nm to 850 nm.

The chipS·CALe photodiodes have also been combined with thermal detection, in a dual-mode self-calibrating detector. By using thermal detection as a built-in reference in the detector, the internal losses of the photodiode can be determined directly, without the need of an external reference. We will present results for room temperature, with an uncertainty of 0.04 %, and our latest results of the ongoing measurements at cryogenic temperatures.

By combining the 3D model fit and the dual-mode methods, we can extract the fundamental constants ratio e/hc from our measurements. This makes the dual-mode detector self-assured, serves as a validation of the two primary methods through a cryogenic high-accuracy comparison on one device, and provides a direct link between radiometric measurements and the new SI.

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New Developments of the NIST Infrared Optical Properties of Materials Program

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ABSTRACT: The Infrared Optical Properties of Materials program in the Sensor Science Division at the National Institute of Standards and Technology (NIST) provides support to a wide range of customers worldwide, including, industry, universities, US government agencies and other National Metrology Organizations (NMIs). Properties characterized include spectral regular reflectance and transmittance, directional-hemispherical (diffuse) reflectance and transmittance, emittance, bi-directional distribution function (BRDF), and index of refraction, over varying ranges of sample size, wavelength, temperature, incidence angle, and polarization. We endeavour to continue to expand our capabilities to meet the demand for high accuracy measurements of optical properties over a wide range of measurement types and key parameters. Here we will focus on a pair of topics: 1) the establishment of a new measurement system, to provide additional and improved measurement capabilities, including new integrating spheres, a hemi-ellipsoidal mirror, and retro-reflection device; and 2) new standard reference materials (SRMs) for specular and diffuse reflectance.

Decadal Validation of the LASP TRF Radiometer by NIST, and Establishment of a Replacement Room Temperature Standard

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ABSTRACT: We present the results of a recent, extensive measurement campaign validating the traceability of the solar irradiance record and earth radiation budget data. The campaign also established future traceability, thus ensuring confidence in the continuing climate-data record. The Total Solar Irradiance Radiometer Facility (TRF) at the Laboratory for Atmospheric and Space Physics (LASP) Boulder, uses a liquid helium cooled cryogenic radiometer as the reference standard for the validation of spaceflight total solar irradiance instrumentation. In 2008 the radiometer was directly compared to the National Institute of Standards and Technology (NIST) Primary Optical Watt Radiometer (POWR) at a wavelength of 532.12 nm. At total solar irradiance power levels, a correction factor of 1.000306 ± 0.000098 (k=1) was reported for the TRF radiometer scale when using external voltage measurement electronics, and not correcting for cavity heating non-equivalence or cavity absorptance. The TRF radiometer has recently been revalidated at LASP using a POWR calibrated silicon photodiode trap transfer standard named TT4. We report a correction factor of 0.999970 ± 0.000294 (k=1) to align the TRF radiometer scale with the current NIST POWR scale.

A new room temperature reference standard radiometer NACR, was established. It measured 49 ppm lower than POWR using the same silicon transfer standard as above, and in a separate direct measurement, 15 ppm higher than the TRF radiometer at a shutter modulation of 200 secs. The difference is in agreement with stated uncertainties. A correction of 1.000049 ± 0.000313 (k=1) will align the new radiometer scale with the NIST radiant power scale of POWR.
All measurements were made in power mode, whereby the radiometer apertures were underfilled.

The presentation will discuss the experimental methodology and results of the comparisons.