Consultative Committee for Photometry and Radiometry (CCPR)

25th Meeting (on-line 10-11 May 2022)

CCPR member report on activities in radiometry and photometry since the last CCPR meeting (2019)

Reply from: National Metrology Institute of Japan (NMIJ, AIST)

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1. Summarize the recent progress in your laboratory with respect to measurement standards, research projects, and metrology services to fulfill the demands of customers in:

(a) broad-band radiometric quantities:

- Characterizing a new home-built mechanically-cooled cryogenic radiometer
- Development of UV-LED irradiance measurement technique by means of a standard UV-LED with a beam homogenizer
- Development of a detection efficiency calibration system for single photon detectors at the wavelengths of 850 nm and 1550 nm

(b) spectral radiometric quantities:

- Development of the spectral responsivity standard in the wavelength range from 1500 nm to 2500 nm
- Updating the realization facilities of spectral irradiance standard with high temperature blackbody furnace and its optical characterization
- Benchmarking commercial radiometers and sources for UV-C in terms of measurement accuracy and photobiological safety
- Characterization of nonlinear properties of silicon photodiodes in ultraviolet range
- Experimental evaluation of supralinear behavior of silicon photodiodes under overfilled illumination in NIR range

(c) photometric quantities:

- Development of an LED-based standard source with omni-directional LID and improved spectral properties that almost covers full visible wavelength range for total spectral radiant flux and luminous flux calibration in 4π geometry
- Error analysis for the measurement of white LEDs based on a 2π standard LED source using a sphere-photometer and a sphere-spectroradiometer
- Development of an LED-based transfer standard source for luminance measurement
- Seeking for alternative incandescent-based standard sources for photometry and radiometry
- Piloting international key comparisons, CCPR-K4.2017 (luminous flux) and APMP.PR-K3.a (luminous intensity).

(d) other area(s) relevant to CCPR:

- Development of large-area flat-plate blackbody material having the mid-infrared emissivity of ≳0.999 for precision thermal imager calibration
- Development of photon number resolving detectors for the precise determination of optical quantum states for the applications of quantum optics and quantum information.
- Development of single-photon camera-like spectral imaging device for bio-imaging with ultra-low invasiveness.
- Development of an LED-based spectrally tunable source for precise lighting booth application in photometry and colorimetry
- Upgrading measurement capability of laser-based BRDF in terms of wavelength range (to NIR region) and measurement area (for micro-BRDF setup)
- Development and publication of document standard (ISO 23946:2020) for gonio-spectrofluorometer-based test methods on optical properties of ceramic phosphors for white LEDs as a co-Project Leader

2. What work in PR has been/will be terminated in your laboratory, if any, in the past /future few years? Please explain the reasons and provide the name of the institution if it has been/will be substituted by a DI or accredited laboratory.

   - N/A

3. Summarize the Capacity Building and Knowledge Transfer activities undertaken by your institute in photometry and radiometry (courses, training, …):

   - Measurement club organized by RIPM (Research institute for physical measurement) under NMIJ offers a dedicated website and annual session to interested customers that includes online poster presentation and lab tour.

4. Summarize the research projects currently performed within a collaboration with one or more NMIs or DIs (name of the project, participants):

   - NMIJ has been taking part as a collaborator in SEQUME (Single and entangled photon sources for quantum metrology; https://sequme.cmi.cz/
   - CCPR WG-KC TG4 Pilot comparison on luminous intensity using a filament-type standard LED source.

5. Are there any other research projects where you might be looking for collaborators from other NMIs or are there studies that might be suitable for collaboration or coordination between NMIs?

   - N/A

6. Have you got any other information to place before the CCPR in advance of its next meeting?

   - N/A

7. Bibliography of radiometry and photometry papers of your laboratory since the last CCPR (September 2019):

1. Y. Shimizu, M. Imbe, K. Godo, N. Sasajima, H. Koshikawa, T. Yamaki, and K. Amemiya, "High-precision flat-plate reference infrared radiator using perfect blackbody composite with a microcavity structure," Applied Optics 61, 517–522; https://doi.org/10.1364/AO.446426 (2022).
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3. N. Namekata, D. Wu, H. Hagihara, S. Ohnuki, D. Fukuda, and S. Inoue, “Continuous quantum walk in a 1-dimensional plasmonic lattice structure based on metal strip waveguides”, Optics Express, 29, 24899-24909; https://doi.org/10.1364/OE.427858 (2021).
4. K. Niwa, K. Hattori, and D. Fukuda, “Few-Photon Spectral Confocal Microscopy for Cell Imaging Using Superconducting Transition Edge Sensor”, Frontiers in Bioengineering and Biotechnology, 78709; https://doi.org/10.3389/fbioe.2021.789709 (2021).
5. 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", Optics Letters 46, 4871–4874; https://doi.org/10.1364/OL.433028 (2021).
6. M. Tanabe, H. Shitomi, T. Dönsberg, E. Ikonen "Characterization of predictable quantum efficient detector in terms of optical non-linearity in the visible to near-infrared range" Metrologia 58, 055012; https://doi.org/10.1088/1681-7575/ac1e35 (2021).
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8. Y. Ikeda, M. Tanaka, R. Nishihara, Y. Hiruta, D. Citterio, K. Suzuki, K. Niwa, “Quantitative evaluation of luminescence intensity from enzymatic luminescence reaction of coelenterazine and analogues” Journal of Photochemistry and Photobiology A-Chemistry, 394, 112459; https://doi.org/10.1016/j.jphotochem.2020.112459 (2020).
9. Y. Iwasa, Y. Su, Y. Tsuchiya, M. Tatsuda, K. Kishio, T. Yanagida, F. Takada, T. Nishio, Y. Tsujimoto, K. Fujii, M. Yashima, H. Ogino "Synthesis, structure, and luminescence properties of layered oxychloride Ba3Y2O5Cl2" J. Mater. Chem. C, 8, 17162-17168; https://doi.org/10.1039/D0TC04415F (2020).
10. K. Godo, "A new traceability chain for luminance scale with LED-based transfer standard", Measurement Science and Technology; https://doi.org/10.1088/1361-6501/aba93c (2020).
11. K. Godo, Y. Tamura, and O. Watari, "Illuminance meter calibration with an LED spectrally tunable light source," Lighting Research & Technology; https://doi.org/10.1177/1477153520905618 (2020).
12. K. Hattori, R. Kobayashi, S. Takasu, and D. Fukuda, “Complex impedance of a transition-edge sensor with sub-microsecond time constant,” AIP Advances 10, 035004; https://doi.org/10.1063/1.5127100 (2020).

13. T. Konno, S. Takasu, K. Hattori, and D. Fukuda, “Development of an Optical Transition-Edge Sensor Array,” Journal of Low Temperature Physics, 199, 27-33; https://doi.org/10.1007/s10909-020-02367-9 (2020).
14. N. Nakada, K. Hattori, Y. Nakashima, F. Hirayama, R. Yamamoto, H. Yamamori, S. Kohjiro, A. Sato, H. Takahashi, and D. Fukuda,” Microwave SQUID multiplexer for readout of optical transition edge sensor array,” Journal of Low Temperature Physics, 199, 206-211; https://doi.org/10.1007/s10909-019-02298-0 (2020).
15. Y. Nakazawa, K. Godo, K. Niwa, T. Zama, Y. Yamaji, S. Matsuoka, “Establishment of 2π total spectral radiant flux scale with a broadband LED-based transfer standard source”, Metrologia, 57, 065024; https://doi.org/10.1088/1681-7575/abba73 (2020).
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17. M. Tanabe "Spectral supralinearity of silicon photodiodes with over-filled illumination in the near-infrared region" Applied Optics Vol. 59(26), 8038-8046; https://doi.org/10.1364/AO.400015 (2020).
18. M. Tanabe, K. Kinoshita "Absolute irradiance responsivity calibration using diode lasers emitting at three wavelengths for tricolor laser applications" Optik 202, 1636532; https://doi.org/10.1016/j.ijleo.2019.163653 (2020).
19. T. Irimatsugawa, H. Yamamori, F. Hirayama, S. Nagasawa., G. Fujii, S. Kohjiro, A. Sato, D. Fukuda, M. Hidaka, Y. Sato, M. Ohno, H. Takahashi, “Degradation of Quality Factor of Superconducting Resonators by Remaining Metallic Film and Improved Fabrication Process Using Caldera Planarization,” IEEE Trans. Appl. Supercond., 29, 1102406; https://doi.org/10.1109/TASC.2019.2905144 (2019).