Optical Radiation News

Published by the COUNCIL for OPTICAL RADIATION MEASUREMENTS (www.cormusa.org) to report items of interest in optical radiation measurements. Inquiries may be directed to the Editor, John D. Bullough, Lighting Research Center, Rensselaer Polytechnic Institute, 21 Union St., Troy, NY 12180. Tel: 518-276-7138 Fax: 518-276-7199 e-mail: bulloj@rpi.edu.

NUMBER 107 FALL 2020

ARTICLE CONTENTS PAGE

CORM NEWS

CIE-CORM 2019 Conference Proceedings Available

The CORM 2019 Annual Technical Conference and 12th Biennial Joint Meeting of the CNC/CIE and USNC/CIE was held on October 28 – 31, 2019 at the National Research Council, Ottawa, Ontario, Canada. Copies of the presentations and materials from this conference can be downloaded from the CORM website at: https://cormusa.org/corm-2019-presentations/

CORM Ninth Report Published

The CORM Ninth Report to national metrology institutes (NMIs) was completed in the spring of 2020, and has been posted on the CORM website. The report includes responses to a survey of practitioners about needs and desired services from NMI organizations, and can be downloaded at: https://cormusa.org/wp-content/uploads/2020/11/CORM-9th-Report-March-2020-1.pdf

CORM Board Election Results Announced

CORM members voted on members of the Board of Directors. Secretary Bob Angelo and board member David Gross were re-elected to terms on the Board. An election to replace outgoing board member Tim Moggridge was also held, and Kevin Lange was elected to complete his term. All terms will end in 2023. Biographical information for Kevin Lange, our new board member, is below.

Kevin Lange is an Application Engineer at Konica Minolta Sensing, specializing in Radiometric and Instrument Systems GmbH products. He is an Electrical Engineer specializing in Photonics. Disciplines include Radiometry, Photometric calibration, Spectroscopy, Fiber Optic components, Photodetectors and light sources.

NIST

NEWS FROM THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Optical and Mechanical Design of a Telescope for Lunar Spectral Irradiance Measurements from a High-Altitude Aircraft

C. J. Zarobila, S. Grantham, S. W. Brown, J. T. Woodward, S. E. Maxwell, D. R. Defibaugh, T. C. Larason, and K. R. Turpie
https://doi.org/10.1063/5.0004848

We have designed a non-imaging telescope for measurement of the spectral irradiance of the moon. The telescope was designed to be integrated into a wing pod of a National Aeronautics and Space Administration ER-2 research aircraft to measure lunar spectral irradiance during flight. The telescope and support system were successfully flown in August 2018 at altitudes near 21 km and at speeds of ∼760 km/h. The wing pod in which the telescope is mounted has an opening through which the moon can be observed. The mount exposes the telescope to high winds, low pressures, temperatures near −60 °C, and vibrations both due to flight and due to the motion of the aircraft on the ground. This required a telescope design with high thermal stability and high resistance to shock. The optical design of the telescope is optimized to have high throughput and spatially uniform transmission from 380 nm to 1000 nm over a field of view about three times the angular size of the moon as viewed from the Earth. The final design resulted in a telescope with singlet design incorporating a 139.7 mm lens with an effective focal length of 377 mm and a field of view of 1.6°. The light from the telescope is introduced into an integrating sphere, which destroys the image and the polarization for measurement by a fiber-coupled spectroradiometer. Herein, we present an overview of the instrument and support system with emphasis on the telescope design. **Contact:** Clarence Zarobila, zarobila@nist.gov.

Direct Method of Extracting Complex Refractive Index from Routine Fourier Transform Infrared Reflectance/Transmittance Measurements

Braden Czapla and Leonard Hanssen
https://doi.org/10.1117/12.2568502

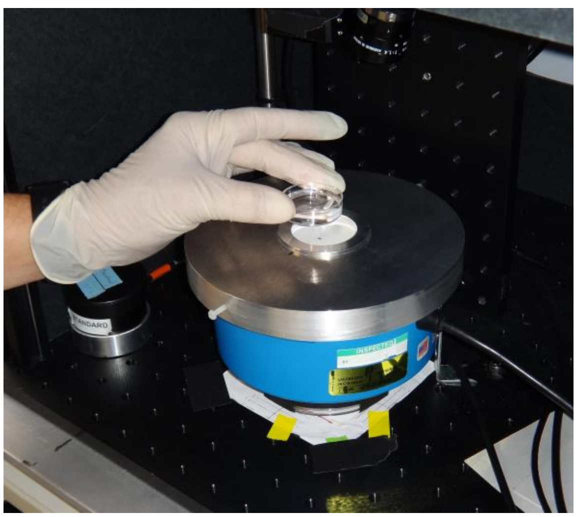
We describe an algorithm to extract the complex refractive index of a material from reflectance and transmittance measurements commonly taken by spectrophotometers. The algorithm combines Kramers-Kronig analysis with an inversion of Fresnel's equations to provide a direct method of solving for the refractive index which is accurate, even for weakly absorbing materials. We discuss the details of the uncertainty analysis of the algorithm. The algorithm is validated by extracting the complex refractive index of polydimethylsiloxane between 2 µm and 18 µm and comparing against existing literature. **Contact:** Braden Czapla, braden.czapla@nist.gov.

National Institute of Standards and Technology Transportable Tunable Ultraviolet Laser Irradiance Facility for Water Pathogen Inactivation

Thomas C. Larason

https://doi.org/10.1063/5.0016500

A method of ultraviolet germicidal irradiation (UVGI) for water pathogen inactivation effectiveness using tunable, narrowband laser light is described. A transportable tunable UV (TTUV) laser system for providing a known irradiance (μW/cm^2) or dose (mJ/cm^2) suitable for irradiating water samples in Petri dishes over the wavelength range of 210 nm–300 nm was developed by the National Institute of Standards and Technology. The TTUV facility, consisting of a 1 kHz pulsed UV laser and light-tight enclosure containing the optics necessary to uniformly irradiate a water sample, was used in a microbiology laboratory to dose drinking water pathogens and surrogates as part of a Water Research Foundation study in the summer and fall of 2012. The approach demonstrated improved accuracy and simplified spectral analysis over conventional pathogen inactivation sources consisting of broadband UV sources and bandpass filters. In this work, the TTUV facility design and key components are described, including modifications in the field to provide the required irradiance levels. The irradiance and dose levels produced by the tunable UV laser during the project are also presented. The transportability of the TTUV system enabled it to be brought to a microbiology facility allowing the water samples (microbial suspensions) to be irradiated in a location with experienced staff and facilities for preparing, handling, analyzing, storing, and shipping the many samples studied. These results, published elsewhere, established that the tunable UV laser system provides unique UVGI capabilities for use with water pathogens and has applications for other pathogen experiments, for example, air-purification studies.



A scientist places a water sample onto a custom-made platform before a test. Each water sample contains microorganisms such as the parasite *Giardia* and adenoviruses, both of which can make humans sick. *Credit: T. Larason/NIST*

Contact: Tom Larason, thomas.larason@nist.gov

Evolution of Transmitted Depolarization in Diffusely Scattering Media
Thomas A. Germer
https://doi.org/10.1364/JOSAA.390598

We performed Mueller matrix Monte Carlo simulations of the propagation of optical radiation in diffusely scattering media for collimated incidence and report the results as a function of thickness and the angle subtended by the detector. For sufficiently small thickness, a fraction of the radiation does not undergo any scattering events and is emitted at zero angle. Thus, for a very small detector angle, the measured signal will mostly indicate the attenuation of the coherent contribution, while for larger angles, the diffuse scattering radiation will contribute significantly more. The degree to which the radiation is depolarized thus depends on the angle subtended by the detector. A three-stream model, where the coherent radiation, the forward diffusely scattered radiation, and the backward scattered radiation are propagated according to the differential Mueller matrix formalism is introduced and describes the results from the Monte Carlo simulations and the results of measurements well. This scatter-based model for depolarization in diffusely scattering media is an alternative to that based upon elementary fluctuation theory applied to a single propagation stream. Results for average photon path length, determined from the Monte Carlo simulations, suggest that applying fluctuation theory to photon path length may unify the two approaches. **Contact:** Thomas Germer, thomas.germer@nist.gov.

Effect of Teflon® Transmittance on Sensitivity of Thermoluminescence Dosimeter Cards
Podobedov, Vyacheslav B.; Miller, C Cameron; Romanyukha, Alexander; Hoy, Andrew
https://doi.org/10.1097/HP.0000000000001149

Thermoluminescence dosimeter cards purchased by the United States Navy in recent years have different radiation sensitivities, e.g. they exhibit a different amount of light per dose unit. Presented tests indicate that the optical transparency of the Teflon® encapsulation is partially responsible for the significant variation of the DT-702/PD radiation sensitivity. It was confirmed also that the Teflon® transparency is in fact a primary cause of the radiation sensitivity increase in the most recently produced dosimetric cards. This conclusion is based on the correlation found between the calibrated radiation sensitivity of the dosimeter card element and the optical transparency of its Teflon® encapsulation. The transparency measurements were performed at the wavelength of 400 nm within a 10 nm spectral interval effectively covering the spectral range of the thermoluminescence. It is anticipated that the experimentally determined correlation will help to approve the acceptance of new thermoluminescence dosimeter cards in the Naval Dosimetry Center inventory as well as improving the production process. **Contact:** Vyacheslav Podobedov, vyacheslav.podobedov@nist.gov.

Index of Refraction of Germanium
John H. Burnett, Eric C. Benck, Simon G. Kaplan, Erik Stover, and Adam Phenis
https://doi.org/10.1364/AO.382408

Measurements of the index of refraction of a sample of high-quality, single-crystal germanium using the minimum deviation refractometry method are presented for temperatures near 22◦C and for wavelengths in the range 2 to 14 µm. The standard uncertainty for the measurements ranges from 1.5×10^{-5} to 4.2×10^{-5}, generally increasing with wavelength. A Sellmeier formula fitting the data for this range is provided. Details of the custom system and procedures are presented, along with a detailed analysis of the uncertainty. These results are compared with previous measurements. **Contact:** John Burnett, john.burnett@nist.gov.

Spatially-Resolved Temperature and Time-Resolved Laser Coupling Metrology

Additive manufacturing involving layer-wise selective laser melting of a powder material, or laser powder bed fusion (LPBF), is a fast-growing industry. In NIST's AMMT, a unique integrating hemispherical reflectometer has recently been developed to perform measurements of spatially resolved emissivity, temperature, cooling rates, and laser coupling of the laser-melting heat affected zone (HAZ) during the LPBF process. A first principles temperature measurement approach is implemented with the indirect measurement of emissivity (1 - reflectance) employing hemispherical illumination within the hemisphere from multiple high-power LED sources. We are also able to measure the time-resolved reflected laser power (laser coupling) with photodetectors sensing within the reflectometer at 50 kHz, at the laser wavelength. The temperature measurement has been validated through comparison with known freeze points of the metals used, and the spatially-resolved temperature profiles are then used to determine post-solidification cooling rates. The time-resolved reflected power measurement was validated with complimentary calorimetry measurements. These recently published measurements of laser coupling and spatially-resolved melt pool temperature profiles are among the most accurate and well validated in the open literature. However, small measurement discrepancies are apparent, for which investigation of several potential causes are planned. **Contact:** David Deisenroth, david.deisenroth@nist.gov, 301-975-2594; Leonard Hanssen, leonard.hanssen@nist.gov, 301-975-2344.

NATIONAL RESEARCH COUNCIL OF CANADA

NRC · CNRC National Research Council Canada Conseil national de recherches Canada

NRC LIAISON REPORT

Artificial Intelligence for Spectral Analysis

Deep learning is a branch of artificial intelligence that is used extensively for pattern recognition in big data. We have explored the use of deep learning in vibrational spectral data analysis, specifically in spectral identification. A deep learning model can extract unique spectral features and use a classifier (e.g. neural network) to identify the features of an unknown sample against those extracted from the spectra in a spectral library. The use of artificial intelligence in spectral feature identification has shown promise over conventional spectral matching algorithms. At NRC, we used a convolutional neural network (CNN), a deep learning classifier, to tackle complex spectrum analysis, specifically, spectra obtained from mixtures of two or more components. In the one-dimensional version, it is shown that when we provide enough mixture samples (by augmentation) to a CNN model, it can recognize components of the mixtures accurately. In the ultimate case, by providing the mole fraction of each mixture in the training stage, quantitative identification is possible. Figure 1 shows our 1D CNN network model (named RaMixNet II) comprising several convolutional layers and two parallel dense classifiers. In evaluating our proposed approach, we could achieve a classification accuracy of 98% and regression accuracy of 88% for the Raman spectra of mixtures (up to four pure compounds). Our approach is suitable for integration into portable Raman spectrometers for identifying mixtures with an arbitrary number of components in the field.

For further information, please contact Li-Lin Tay, 613- 993-3919 (Li-Lin.Tay@nrc-cnrc.gc.ca) or M. Hamed Mozaffari, 613-990-4860 (MHamed.MozaffariMaaref@nrc-cnrc.gc.ca)

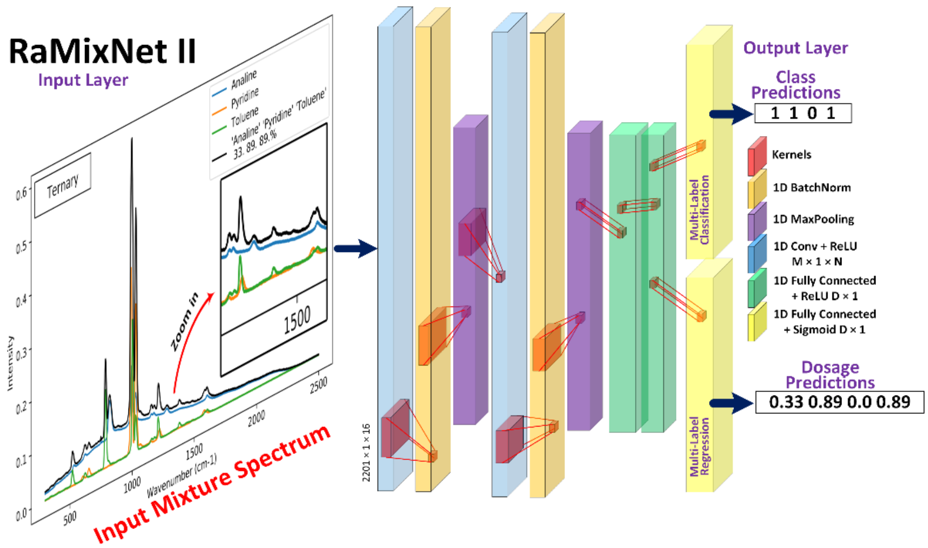


Figure 1. *Network structure of RaMixNet II for quantitative and qualitative analysis of Raman spectrum of mixture compounds.*

Radiative Transfer in Fluorescent, Scattering Media

The transport of fluorescence in scattering media is of interest in a number of scientific and industrial contexts, including phosphor materials used in solid state lighting and optically-brightened textiles and paper. We have developed a model of radiative transport in fluorescent, scattering media based on the P3 approximation, a well-established approximate solution to the radiative transfer equation. Importantly, our model accounts for fluorescence re-absorption/re-emission events, wherein a fluorescence photon may be re-absorbed and re-emitted multiple times before exiting the material. Accounting for such inner filter effects is important for accurately modelling the optical properties of fluorescent, scattering media, e.g., the spectral characteristics and intensity of the fluorescent emission as a function of fluorophore concentration. Calculations carried out for a toy system, sintered PTFE doped with fluorescent rhodamine 6G, suggest that the new model qualitatively reproduces many of the trends reported in experiments on fluorescent, scattering media.

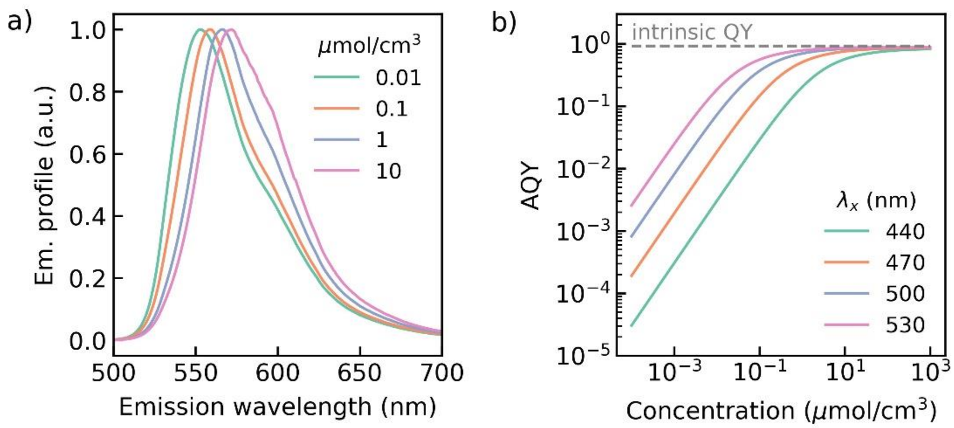


Figure 2. *Model spectral characteristics of R6G:PTFE: a) Normalized emission profile under 480 nm excitation for select fluorophore concentrations. b) Apparent quantum yield (AQY) versus fluorophore concentration for select excitation wavelengths. The emission profile red shifts as concentration increases, a classic inner filter effect. The AQY is defined as the number of photons emitted as a fraction of photons absorbed. The AQY varies with excitation wavelength and increases linearly with concentration before saturating at a value close to the intrinsic QY of R6G.*

For further information, contact Luke Sandilands (luke.sandilands@nrc-cnrc.gc.ca).

Few-Photon Metrology at NRC: Update

In support of the few-photon metrology capability at NRC, a detection efficiency calibration system for free-space single-photon detectors has been constructed. This measurement apparatus utilizes a double-attenuation and detector substitution calibration technique [1] with an 850 nm fiber laser source. The calibration of silicon single-photon avalanche photodiodes (SPADs) is SI traceable through the substitution configuration with a silicon transfer standard radiometer, calibrated directly using the NRC absolute cryogenic radiometer. To validate this new single-photon detector efficiency calibration system, SPAD detection efficiencies were measured at NRC with this new calibration apparatus and at the National Institute for Standards and Technology (NIST), using a calibration set-up described in Ref. [2]. A manuscript presenting the results of these comparison measurements and the uncertainty budget for the NRC single-photon detection efficiency calibration system is presently in preparation.

[1] M. López, et al., "Detection efficiency calibration of single-photon silicon avalanche photodiodes traceable using double attenuator technique." Journal of Modern Optics, 62, 1732 (2015).
[2] T. Gerrits, et al., "Calibration of free-space and fiber-coupled single-photon detectors." Metrologia, 57, 015002 (2020).

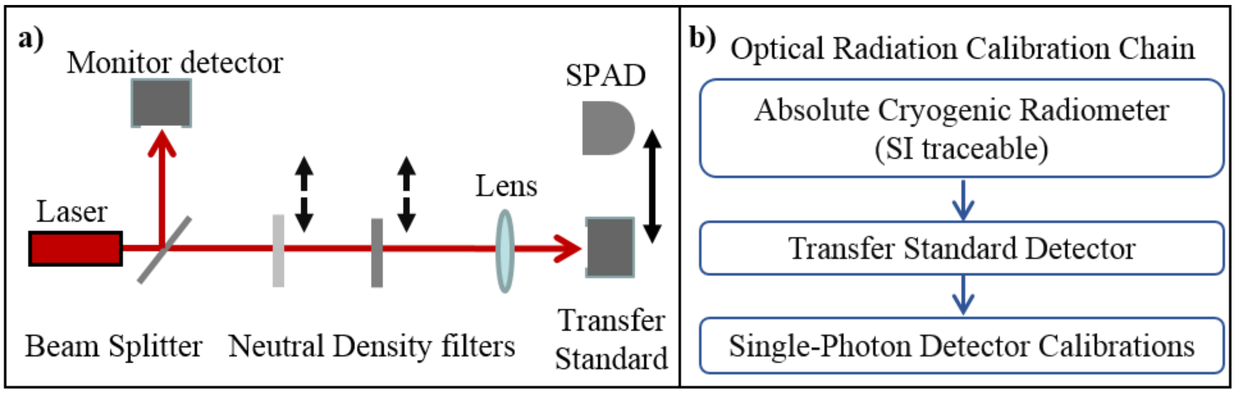


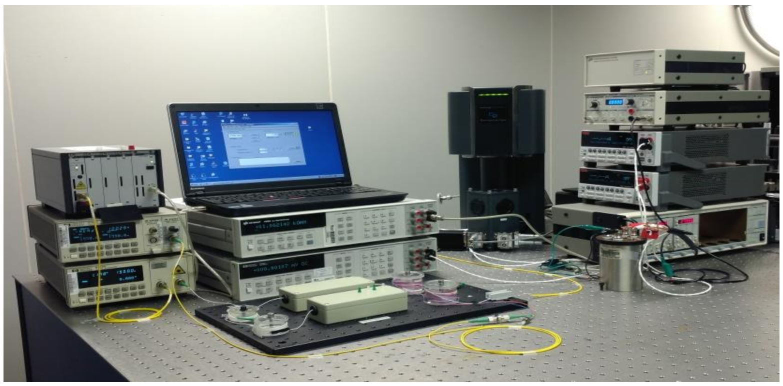
Figure 3. *a) Simplified schematic diagram of SPAD calibration apparatus. b) NRC traceability chain.*

For further information, contact: Jeongwan Jin (jeongwan.jin@nrc-cnrc.gc.ca) or Angela Gamouras (angela.gamouras@nrc-cnrc.gc.ca).

NEWS FROM CENTRO NACIONAL DE METROLOGÍA MÉXICO (CENAM)

Fiber Coupled Cryogenic Radiometer at CENAM

As part of NIST on a Chip Program, the Sources and Detectors Group of NIST in Boulder CO, invited CENAM to be part of the development of a cryogenic primary standard for optical fiber power measurement and calibration to establish a direct traceability route between the device under test and the primary standard. With this novel design, we can achieve uncertainty values below 0.5% at k = 2, which represents a 50% improvement of CENAM`s current calibration capabilities. CENAM played an important role in characterizing fiber-connector losses and uncertainty as well as programming and documentation.



Fiber Coupled Cryogenic Radiometer and its instrumentation at CENAM.

To ensure the performance of the Fiber Coupled Cryogenic Radiometer, we have made several comparisons between the certified calibration values of our working standards (InGaAs detectors) using the traditional calibration method and the calibration values obtained with this cryogenic primary standard and the obtained results were identical.

This next-generation standard will be part of the CPEM International pilot study on optical fiber power responsivity using fiber coupled cryogenic radiometers in conjunction with NIST, CMI and other National Institutes of Metrology around the world. [Contact: Zeus Ruiz, zruiz@cenam.mx]

Classification of Industrial Large Area Solar Simulators

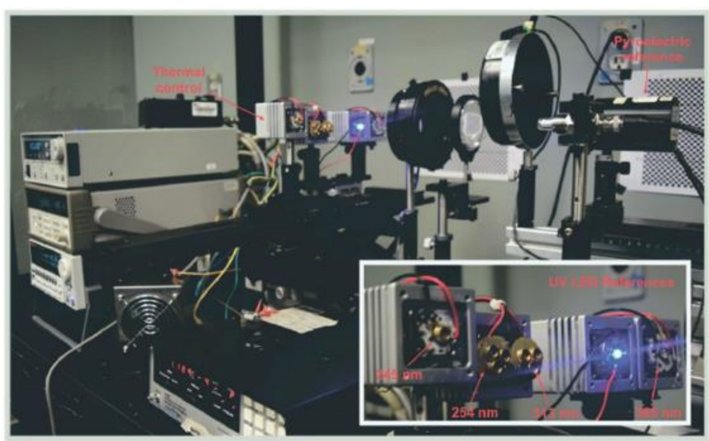
In all companies that manufacture photovoltaic solar modules, the photoelectric test during the assembly process and the final measurements of photoelectric performance at standard test conditions are essential to control the quality of the product and its labeling specifications. The measurements needed that involve module lighting are performed by means of a large area solar simulator, which requires metrological control to classify the spectral match of the light source, the non-uniformity of the irradiance in the plane of the module and the temporal stability of the light source.

In recent months, CENAM has continued the development of measurement instruments for the non-uniformity of light intensity in large-area solar simulators. These instruments are called simulator calibrators and are used in the classification of solar simulators according to the IEC 60904 standards series. To perform the classification of pulsed solar simulators, located in photovoltaic module manufacturing plants, it is necessary to use the calibrators, spectrometers and current-voltage tracers to measure the emission spectrum of the simulator, the irradiance distribution in the measurement plane and the short- and long-term stability of the light pulses emitted during the test of solar photovoltaic modules. [Contact: Héctor Castillo M., hcastill@cenam.mx]

System under development for the classification of wide area solar simulators.

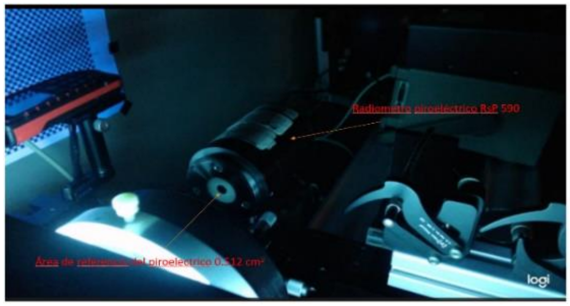
New Calibration and Characterization Services for UV Surface Disinfection Systems

Currently, at the international level, there is no doubt that the SARS-CoV-2 virus, which causes COVID-19, is effectively destroyed by wavelength 254 nm UV radiation. The world's most advanced Metrology nstitutes, NIST (USA) and PTB (Germany) are working on technical and scientific support to efficiently implement the use of UV radiation sources for the disinfection of SARS-CoV-2 in physical spaces used by humans (warehouses, transport, hospitals, buildings). This effect will help mitigate the advance of the pandemic and provide the general population with certainty that the public spaces we use are safe again.

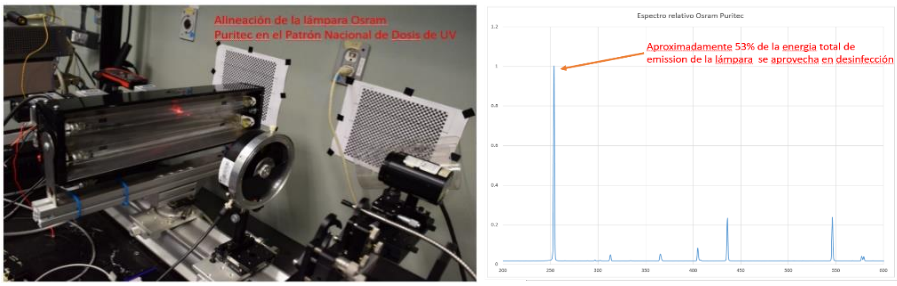


CENAM's UV irradiance and doses calibration system.

The Centro Nacional de Metrología in Mexico has made advances in the use of UV radiation for disinfection. Since 2017, calibrations have been performed using LED-based radiation sources that are more effective, stable and durable than commercial lamps used for disinfecting. The measurement system installed at CENAM has served as a national reference for more than 10 years to provide calibration and advisory services to users of UV meters in industrial disinfection processes. The current challenge is to adapt the dose of UV radiation to bring them to adequate values and achieve the correct disinfection of SARS-CoV-2 and extend the results to all companies and organizations that begin to use UV radiation to disinfect their public spaces.



Calibration by substitution method.



Characterizing UV lamps used for disinfection.

It is important to verify that any UV disinfection system achieves the necessary dose values. This is achieved by reviewing the actual values of the UV radiation sources and providing advice and training to the developers of these disinfection systems on measuring procedures, so they can assure the appropriate dose is provided by its systems. Specialized consulting services, calibration or verification of equipment, technological accompaniment to development projects and characterization of commercial sources of UV radiation are already available today. [Contact: Noe Vidal, nvidal@cenam.mx]

UPCOMING IES MEETINGS CALENDAR

The Illuminating Engineering Society (IES) is sponsoring the following meetings and conferences in the coming months (specific details are subject to change during the ongoing pandemic):

2021 Lighting R&D Workshop (Co-Sponsored with the U.S. Department of Energy)
Virtual Event
February 1-4, 2021
https://www.energy.gov/eere/ssl/2021-lighting-rd-workshop

LightFair
New York, NY
October 25-29, 2021
http://www.lightfair.com

NEWS FROM THE CIE

International Commission on Illumination
Commission Internationale de l'Eclairage
Internationale Beleuchtungskommission

Upcoming Events (subject to change; please check www.cie.co.at for latest details)

CIE Australia Lighting Research Conference 2021
Virtual Event
February 9, 2021
http://www.cie.org.au/calreco2021.html

Lichttechnische Gesellschaft Österreichs (LTG) - Lighting Congress 2021
Linz, Austria
June 15-16, 2021
http://ltg.at/pages/anmeldung-lichtkongress-2021.php

CIE 2021 Midterm Meeting
Kuala Lumpur, Malaysia
September 26-Octoner 2, 2021
http://cie.co.at/news/cie-midterm-meeting-2021

New Publications

The following documents were published by CIE in 2020:

- CIE TN011:2020 What to Document and Report in Studies of ipRGC-Influenced Responses to Light
- CIE 241:2020 Recommended Reference Solar Spectra for Industrial Applications
- CIE 240:2020 Enhancement of Images for Colour-Deficient Observers
- CIE Position Statement on the Use of Ultraviolet (UV) Radiation to Manage the Risk of COVID-19 Transmission
- CIE 239:2020 Goniospectroradiometry of Optical Radiation Sources
- CIE 238:2020 Characterization of AC-Driven LEDs for SSL Applications

Visit http://www.cie.co.at for additional information.

OTHER NEWS…

Lighting Research Center Held Online Course on UV Measurement and Application

The Lighting Research Center (LRC) developed an online course held on September 14 and September 16, to assist lighting specifiers, facility managers, end-users and others to ensure that the UV systems they select are safe, being applied properly in each application, and are effective at providing required disinfection properties. Course participants learned about the radiometric measurements units of UV radiation; characteristics of sources of UV radiation including life, efficacy, spectrum, size, and optical distribution; and proper safety and personal protection when working with UV products. The course was sponsored by the New York State Energy Research and Development Authority with equipment provided by Gigahertz-Optik. Information about this course is online at: https://www.lrc.rpi.edu/education/outreachEducation/uv.asp

Lighting Answers: UV Disinfection Products

The Lighting Research Center (LRC) announces the publication of *Lighting Answers: UV Disinfection Products.* This publication includes information on products that produce optical radiation at specific ultraviolet (UV) or very short visible wavelengths, designed for use in disinfecting indoor building surfaces and/or air. Three key aspects of UV disinfection are considered throughout the document: product effectiveness, radiation safety, and energy use in buildings. The publication includes the results of LRC testing of twelve UV disinfection products, representing a variety of product types. This analysis includes a review of manufacturer claims of product performance and well as LRC evaluation of other key attributes of product performance. The publication can be found https://www.lrc.rpi.edu/programs/nlpip/publicationDetails.asp?id=949 online at: https://www.lrc.rpi.edu/programs/nlpip/publicationDetails.asp?id=949

Strategies in Light Announcement

Strategies in Light connects technology, lighting, and the built environment, providing a unique 360-degree platform for information exchange, collaboration and networking. Conference speakers and panelists present cutting-edge technical, application, and research content that shapes the lighting and building communities. Strategies in Light provides a collaborative, integrated event experience for professionals representing the entire spectrum of lighting in the built environment including emerging technologies; design and development; manufacturing; application; design and specification, installation and construction; and operations and maintenance. The 2021 event will be held on August 24-26, 2021 in Santa Clara, CA. For more details, visit: https://www.strategiesinlight.com.

Purpose of the Council for Optical Radiation Measurements (CORM)

The Council for Optical Radiation Measurements is a non-profit organization with the following aims:

1. To establish and publish consensus among interested parties on national, industrial and academic requirements for physical standards, calibration services, and inter-laboratory collaboration programs in the fields of optical radiation measurement, including measurement of the transmittance and reflectance properties of materials, measurement of radiant sources, and characterization of optical detectors used for the measurement of these properties.
2. To establish national consensus on the priorities for these requirements.
3. To maintain liaison with the National Institute of Standards and Technology (NIST) and The National Research Council Canada (NRC) and to advise the Institute(s) of requirements and priorities.
4. To cooperate with other organizations, both public and private, to accomplish these objectives for the direct and indirect benefit of the public at large.
5. To assure that information on existing or proposed standards, calibration services, collaboration programs, and its own activities is widely disseminated to interested parties.
6. To answer inquiries about such standards activities or to forward such inquiries to the appropriate agencies.

Optical Radiation News Editorial Policy

Optical Radiation News (ORN) is published semi-annually each year. ORN reports upcoming technical meetings and news from NIST and other national metrology laboratories. News relating to the status and progress in optical radiation metrology from affiliated organizations, including, but not limited to, the *Commission International De Éclairage* (International Commission on Illumination, CIE), Inter-Society Color Council (ISCC), Lamp Testing Engineers Conference (LTEC), etc., is welcome. No commercial advertising, endorsements, or contributions with commercial content are included in ORN. Unsolicited contributions are subject to review and approval by the editor, CORM publications committee, and /or executive board prior to publication. Anonymous contributions will not be accepted. Contact information for a submission is required and will be published. ORN is included free with CORM membership.

Instructions for Contributing Authors

ORN is published in English. Deadlines for submission of News items and announcements concerning optical radiation metrology are 1 March and 1 September. Items may be submitted to the editor in via fax or e-mail attachments in plain ASCII text or common electronic word processing file formats, preferably Microsoft Word® or Corel WordPerfect®. Contributions should be in 12 point Times New Roman font with simple formatting, e.g., the "Normal" style and template in Word. *Use of complex style templates and formatting is strongly discouraged*. Submissions with high quality pertinent electronic graphics are welcome, however digital photographs and graphics will be reproduced in black-and-white or grayscale. Graphics included in hardcopy submissions via fax will not be reproduced. Submissions are credited to organizations, rather than individuals.

Policy on Commercial Activities at CORM Conferences

The Council for Optical Radiation Measurements (CORM) does not permit commercial activities in conjunction with technical sessions of CORM conferences and CORM workshops. Commercial activities include, but are not limited to, product exhibition and dissemination or display of advertising in any format. Speakers at CORM conferences and workshops may not use talks for overt commercialization of products. Commercial activities as defined above are permitted for a fee for defined periods prior to social activities associated with the conference or workshop at the discretion of the CORM Board of Directors. Registration requirements, details of the structure of the allowed activities and fees are (event and site) specific.

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