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: 518-687-7100 Fax: 518-687-7120 e-mail: bulloj@rpi.edu.

NUMBER 105 FALL 2018

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SAVE THE DATE! JOINT CIE-CORM 2019 CONFERENCE

CORM is pleased to announce that a joint CIE-CORM conference will be held the week of October 28, 2019. The conference will be held at the National Research Council in Ottawa, Canada.

CORM 2018 CONFERENCE SUMMARY

The annual conference for CORM was held in Gaithersburg, Maryland from July 29th to August 1st, in conjunction with the National Institute for Standards and Technology (NIST). CORM board members David Gross and Massy Anaya served as conference coordinators. The conference featured a session on solid state lighting applications and standardization. Rolf Bergman presented a summary of proficiency testing from the National Voluntary Laboratory Accreditation Program (NVLAP). From industry, Andy Jackson from Signify discussed measurements to characterize flicker and stroboscopic effects, and Chris Durell from Labsphere discussed measurements of short-wave infrared (SWIR) energy. From NIST, Yuqin Zong compared pulse and DC methods of measurement for light emitting diodes (LEDs), and Cameron Miller discussed goniophotometric and sphere-based measurements of LED lighting products.

In a session on ultraviolet (UV) radiation measurements, Ralf Dreiskemper from Heraeus described measurements of UV LED sources. Mike Clark from Gigahertz-Optik discussed stray light correction in a UV array spectroradiometer. Presentations from NIST in this session included one by George Eppeldauer on an 365-nm irradiance standard for LED sources and one from Cameron Miller on the use of UV to reduce infections in healthcare environments. The session was closed following a presentation by David Sliney on measurement issues with UV sources as they pertain to photobiological safety.

A session on the optical properties of materials featured a presentation by Alexandre Castagna Mourão e Lima from the University of Ghent on irradiance measurements using Spectralon panels, followed by a presentation by Jinan Zeng from the National Aeronautics and Space Administration (NASA) on the measurement of black materials. Eric Shirley of NIST spoke on the calibration of 0/45 lamp-plaque sensor systems, and Luke Sandilands from the National Research Council (NRC) of Canada described issues with sphere-based photoluminescence measurements. Benjamin Tsai from NIST gave a talk on UV-induced diffuser degradation.

The next session featured ongoing research at NIST and NRC, including a description of NIST's refractometry facility by John Burnett of NIST, an overview of Canadian research activities by Angela Gamouras of NRC, a study of the Hunt effect by Yuki Kawashima of NIST, a discussion of the stability of the spectral irradiance scale by Howard Yoon of NIST, an investigation of Mueller matrix imaging by Joseph Angelo of NIST, and a discussion of spectral irradiance and radiance responsivity calibrations by Brian Alberding of NIST.

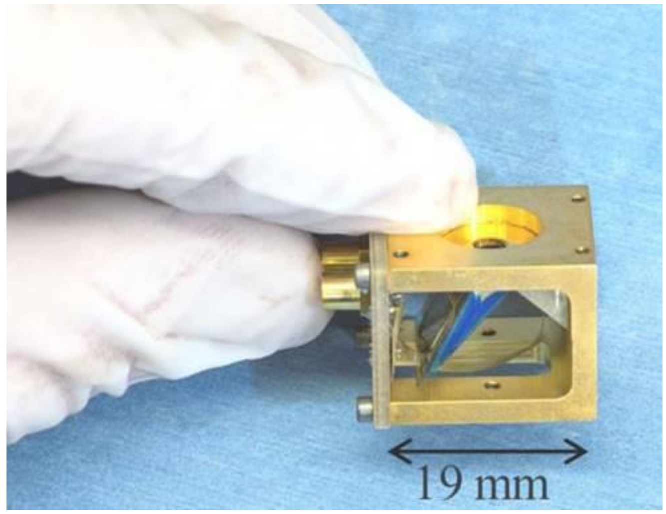
Finally, a special session featuring emerging professions was held. This session included presentations by Jie Yang from the Rochester Institute of Technology (RIT) on multispectral imaging techniques for detecting crime-related bloodstains, by Yousra Ahmed of Purdue University on using ray tracing to simulate ultraviolet fluence rates in photoreactors, and by Sarah Safranek of the Pacific Northwest National Laboratory (PNNL) on errors in high dynamic range luminance measurements.

CORM NINTH REPORT SURVEY RESPONDENT WINNERS ANNOUNCED

CORM is busy preparing its Ninth Report to National Metrology Institutes containing recommendations from industry and academia regarding the measurement and characterization of optical radiation and optical materials. Four lucky individuals among respondents to the survey CORM developed to help in preparation of the Ninth Report, won a drawing for gift cards to Amazon: Mike Clark ($100), Steve Ellersick ($50), Douglas Doss ($25) and Rolf Bergman ($25). Congratulations to the winners, and thank you to everyone who provided responses to CORM's survey!

NEWS FROM THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

NIST article describing a newly developed high-performance infrared detector selected as an Editor's Pick by *Applied Optics*. Applied Optics has chosen the article titled "Wideband infrared trap detector based upon doped silicon photocurrent devices" by PML/Sensor Science Division staff members Solomon Woods and Dana Defibaugh and associates Jim Proctor, Tim Jung, Adriaan Carter, and Jorge Neira as an Editor's Pick. The article describes the design, fabrication, and performance of a new type of infrared trap detector based on arsenic-doped silicon blocked impurity band photodetectors. When cooled to 10 K, these fast, Si-based detectors have a quantum efficiency of greater than 90 % over an extremely broad range of the infrared, i.e., from 4 μm to 24 μm. The detectors also display excellent spatial uniformity of 1 % and. The detectors have femtowatt levels of sensitivity, with noise levels corresponding to approximately 10,000 short wavelength infrared photons per second. Such sensitivities allow these detectors to bridge the gap between single-photon and standard infrared detectors, which could enable a single optical power scale which encompasses both. Together, these characteristics make the new detector an excellent choice for applications in infrared radiometry. A photograph of the detector package is shown in the figure below. [POC: Solomon Woods, x2382, **solomon.woods@nist.gov]**



A new NIST photometry bench for calibrating solid-state lighting sources is operational. The photometric bench was developed by PML Sensor Science Division scientists Yuqin Zong, Maria Nadal, and Cameron Miller to meet the growing demand for calibrations in support of the commercialization of solid-state lighting products. Customers for these calibrations include commercial calibration laboratories and lighting manufacturers. The new bench allows NIST customers to realize the full benefit of the improvements in the NIST realization of the candela, one of the 7 SI base units. The new NIST realization lowers the uncertainty for the candela realization by a factor of three, leading to a new expanded uncertainty of 0.20 % (k = 2), the lowest uncertainty in the world for such a realization. Photometric standards calibrated on the bench and tied to the candela will also see lower uncertainties. Particularly important for achieving the lower uncertainties in disseminated calibrations are the improvements in distance measurement between light source and detector and in alignment and positioning made possible by the new bench. Moreover, advances in automation and in light-source and detector mounting will enable the photometric measurement services to deliver calibrations with shorter turnaround times and greater reliability. [POC: Yuqin Zong, x2332, yuqin.zong@nist.gov; Maria Nadal, x5949, maria.nadal@nist.gov; and Cameron Miller, x4713, c.miller@nist.gov]

Successful NASA ER-2 aircraft flight provides first data set of NIST lunar irradiance measurements from virtually above the atmosphere. The reflectance of the moon is stable to a part in 10^8 per year, and as such the moon is routinely viewed by many normally-Earth-viewing satellites to track optical/infrared relative sensor stability. To fully utilize the moon as a celestial spectral irradiance standard, calibration against NIST standards from ground-based observatories is an ongoing project.[1] A major limiting factor for lunar calibration measurement from ground-based observatories has always been correction of the Earth's atmosphere. It has long been recognized that a better way to calibrate the lunar irradiance is from above the atmosphere, or as high up as one can get. A team of PML scientists from the Sensor Science Division did just that: In the early-morning hours of August 2, NIST made the first spectral lunar irradiance measurements from above the Earth's atmosphere from a NASA ER-2 aircraft flying at 20 km altitude (which is above most of the atmosphere). A team of PML scientists from the Sensor Science Division developed a specialized instrument, called Air-LUSI (LUnar Spectral Irradiance), over the course of the past year. This involved integrating a NIST-calibrated spectrometer, integrating sphere, and custom-designed telescope system into a wing-pod of the ER-2 aircraft, re-calibrating it on-site at NASA Armstrong Flight Research Center in Palmdale, California, and programming its computer to operate autonomously to track the moon and measure lunar irradiance during the flight. These data, as well as additional data to be collected in the winter on follow-on flights, will act as tie points for validating/correcting the ongoing NIST mountain-based measurements. The NIST Air-LUSI team consists of Steven Brown, John Woodward, Steven Grantham, Thomas Larason, Clarence Zarobila, Dana Defibaugh, and Stephen Maxwell, assisted at critical points by three instrument machinists in the NIST shops: Jay Nanninga, Aaron Young, and Richard Lake. In a related article, *EOS Earth and Space Science News*, the news magazine for the more than 60,000 member American Geophysical Union (AGU) published a story on PML's effort to make accurate, SI-traceable measurements of the reflected solar radiation from the Moon [2]. [POC: Steve Brown, steven.brown@nist.gov x5167 and John Woodward, john.woodward@nist.gov x5495].

[1] https://www.nist.gov/news-events/news/2017/10/how-bright-moon-really

[2] https://eos.org/articles/exact-moonlight-measurements-could-aid-earth-observing-missions

Compact, single-laser, Li magneto-optical trap (MOT). As part of an effort to advance the miniaturization of cold-atom trap technologies for applications in quantum-SI vacuum standards, researchers in the PML Sensor Science Division demonstrated the creation of a cold-atom trap of ^{7}Li atoms by using a nanofabricated, U.S.-quarter-sized diffraction grating, as pictured below.

The aluminum diffraction grating, fabricated in the NIST NanoFab, consists of roughly 10,000 concentric equilateral triangular grooves of nanoscale width and depth, trimmed by a circle of 22 mm diameter. The grating takes a circularly polarized laser beam incident on the chip and diffracts it into the beams necessary for cooling and trapping. The design reduces the 6 input beams of a traditional MOT to a single input beam. The central triangular through-hole allows the atoms to be loaded from behind the chip. The team successfully demonstrated that the grating MOT can effectively trap about 200,000 ^{7}Li atoms and cool them to about 700 μK. This chip will be used for development of next generation quantum-SI cold-atom based sensors and standards. [POCs: Dan Barker, x0544, daniel.barker@nist.gov; Steve Eckel, x8571, stephen.eckel@nist.gov; Jim Fedchak, x8962, james.fedchak@nist.gov; Nikolai Klimov, x3517, nikolai.klimov@nist.gov; Eric Norrgard, x3257, eric.norrgard@nist.gov; Julia Scherschligt, x5328, julia.scherschligt@nist.gov]

International Energy Agency (IEA) sponsors laboratory comparison of measurements on LED luminaires. PML/Sensor Science Division NIST Fellow Yoshi Ohno is leading, under the auspices of the IEA and with support from the US Department of Energy, a large international comparison of measurements on LED luminaires using goniophotometers. Goniophotometers are instruments that measure the output of a light source, such as an LED, as a function of viewing angle. The 43 participants from 18 countries primarily consist of testing laboratories seeking proficiency testing for laboratory accreditation in support of national regulations in solid-state lighting products. Additional benefits of the comparison are that it provides a measure of the quality and comparability of LED measurements for laboratories around the world and will aid the standardization of measurement procedures and uncertainty budgets. The measurements are expected to start in December. [POC: Yoshi Ohno, x2321, yoshi.ohno@nist.gov]

Additive Manufacturing Metrology Testbed (AMMT) completes its first fully monitored 3D build. The AMMT is a testbed for laser powder-bed additive manufacturing in which a laser melts and fuses metal or other powders into a desired structure. The AMMT was designed to provide critical process data and to enable the testing and development of new inline diagnostic and monitoring tools for use in additive manufacturing. The 3D build was done in support of the NIST AM Bench Project (https://www.nist.gov/ambench). The 625 layer build, with each layer adding approximately 20 micrometers of Inconel metal to the structure, lasted over eight and a half hours and is the result of the collaboration involving PML, EL and MML staff members and contractors. The inline process monitoring system imaged the laser-driven heat affected zone (HAZ) at a rate of 10,000 frames per second to provide temperature maps throughout the process. Images consisted of 120 x 120 pixels with each pixel being approximate 8 micrometers across. The full study captured 4,444,252 frames that were compressed into 21 gigabytes of data.

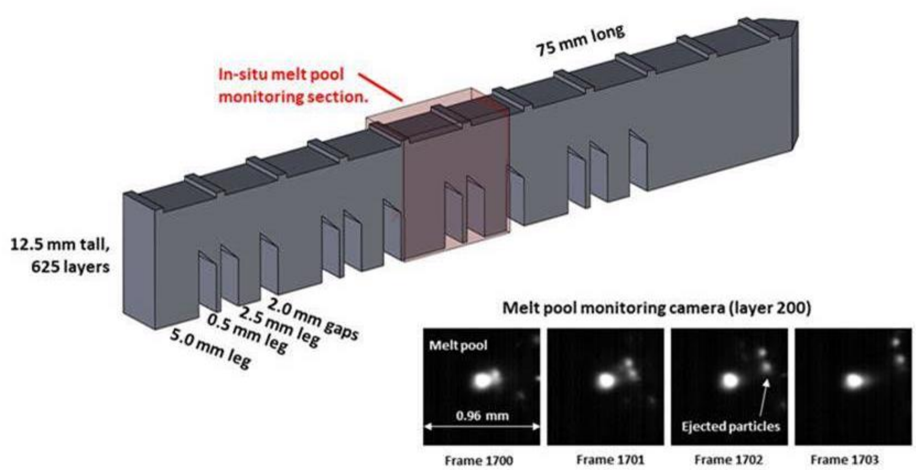


Figure Caption: *Test structure used to test the 3D build and thermal monitoring capabilities of the AMMT. Four sequential frames from the monitor camera that were captured during the build are also shown.*

The laser was triggered so that images were only acquired when the laser beam was within a specified 12 mm x 6 mm region of the part. The PML Sensor Science Division is providing key support for this EL-led project by delivering radiometric temperature calibrations used to determine temperature distribution within the HAZ. The capability to generate calibrated temperature maps of the HAZ, is just one of several capabilities that makes the AMMT a unique research facility in the rapidly expanding field of additive manufacturing. [POCs: Brandon Lane, brandon.lane@nist.gov, x5471, EL/Intelligent Systems Division; Steve Grantham, steven.grantham@nist.gov, x5528, PML/Sensor Science Division]

NATIONAL RESEARCH COUNCIL OF CANADA

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

NRC LIAISON REPORT

Few-Photon Metrology at NRC: Update

NRC has been working to establish a few-photon metrology capability for optical radiometry. The initial goal of this new facility is to measure the detection efficiency of free-space single-photon detectors using a calibrated detector substitution technique. This capability will then be extended to the traceable characterization of NRC on-chip semiconductor quantum dot-based single-photon sources, the evaluation of these sources as new quantum standards, and using entangled photons from these sources for fundamental quantum metrology measurements. NRC is currently collaborating with NIST in the construction of a fibre-coupled superconducting nanowire single-photon detector (SNSPD) system. Two NRC researchers will travel to NIST Boulder in October 2018 to complete the construction and installation of SNSPDs in a closed-cycle cryostat system. This detector system will be characterized at NIST before being shipped to NRC in Ottawa, Canada. The system will then be characterized at NRC and used for fundamental quantum state measurements.

For further information, contact: Angela Gamouras, 613- 993-2489 (angela.gamouras@nrc-cnrc.gc.ca)

NRC Solid State Lighting Measurement Laboratory: Update

We are continuing photometric measurements of commercial “corn cob” LED sources inside our 3-m integrating sphere (Figure 1). The lamp geometry provides omnidirectional lighting inside the sphere. The lamp currently under test has a nominal output of 2680 lumens at 22W (ac). We removed the ac-dc converter inside the base of the lamp to ensure that the voltage and current are controlled by dc power supply only. The lamp was aged for 350 hours and it was observed that although the current was constant to within 0.2mA, the photometric lamp output rose with a parabolic shape reaching a horizontal line after approximately 400 hours (see Figure 1). We also tested the reproducibility on this lamp by On-Off sequences. The results show a decay of output due to a thermal effect, and after equilibrium the variations follow the curve shown in Figure 1. We are planning to add an aperture to the integrating sphere to be equipped with spectrometer, so that in the near future photometric and spectroradiometric outputs of lamps can be monitored simultaneously.

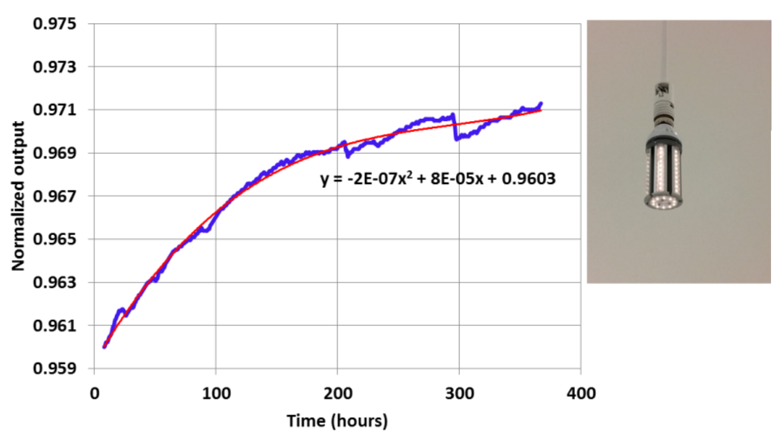


Figure (1) Normalized output of “corn cob” lamp inside 3-m integrating sphere as function of time (blue) with a trend line fit (red).

We also studied the effect of temperature on LED output using a chip-on-board (COB) source. The geometry of LED COBs enables thermal conduction between the front and back surfaces. A thermoelectric cooler/heater stage is used to control and change the temperature of the COB by 0.1°C every 20 minutes. while a photometer in front of the source records its output. It was observed that an increase of temperature reduces the LED output (Figure 2) and the forward voltage. The photocurrent shows a drop of -0.02% per degree Celsius increase in the COB temperature. Further measurements are in progress to study the effect of temperature on the spectrum of LED.

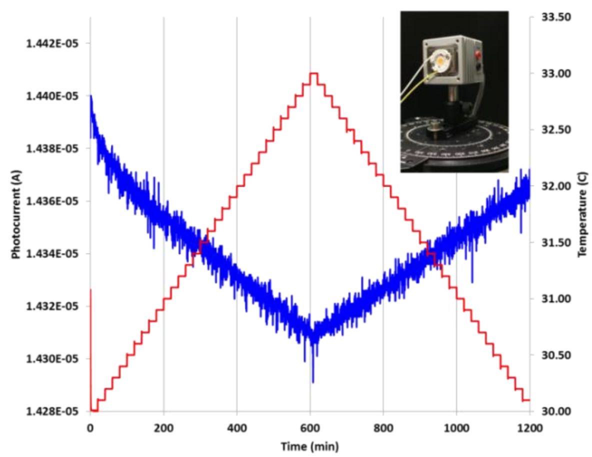


Figure (2) Output of a COB LED source (blue) as a function of its temperature (red) on the back surface controlled by a thermoelectric cooler/heater device. Inset: Image of the COB LED mounted on a thermoelectric stage.

For further information, contact: Amin Rasoulof, 613- 991-2399 (amin.rasoulof@nrc-cnrc.gc.ca)

NRC Sphere-Based Fluorescence Measurements: Matrix Approach to Reducing Sphere Errors

NRC has developed a matrix approach to absolute photoluminescence measurements with integrating spheres. This method, based on the Donaldson reflectance factor matrix formalism for describing reflection from photoluminescent surfaces, corrects for systematic sphere errors associated with multiple reflection effects in the integrating sphere that make the sample illumination and sphere throughput sample dependent. This matrix method has been experimentally validated using the NRC Reference Goniospectrofluorimeter, equipped with two different sized integrating sphere accessories (20 cm and 30 cm diameter), and a doped sintered PTFE photoluminescent test standard having significant spectral overlap of its excitation and emission bands. The spectral emission and absolute spectral quantum yield data collected using the two different spheres, after correction using this matrix method, were in excellent agreement, both for absolute scale and spectral shape, as illustrated in Figure 3 below.

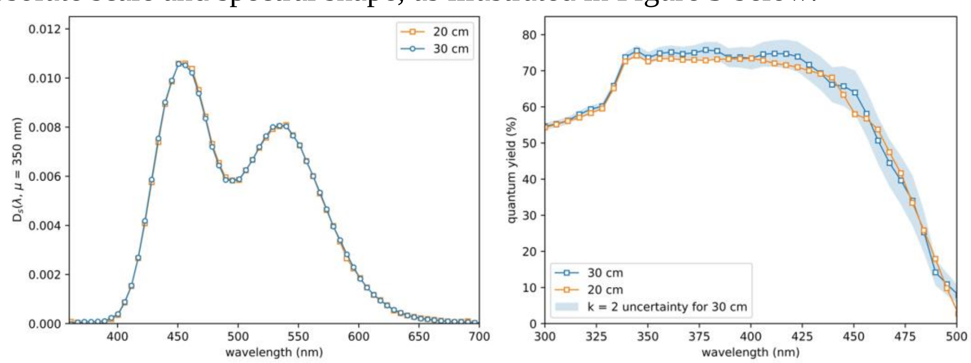


Figure 3: Comparison of absolute photoluminescence measurement results for the 20 cm and 30 cm sphere data sets: (left) absolute spectral emission under 350 nm excitation; (right) absolute spectral quantum yields compared with experimental reproducibility.

The matrix method, although developed for the measurement of surface photoluminescence, should be applicable to other common experimental geometries, including volume fluorescence of liquid samples, provided both direct and diffuse illumination bispectral data can be acquired.

For further information, contact Luke Sandilands, 613-990-8990 (luke.sandilands@nrc-cnrc.gc.ca)

Recent Advances in Solid State Science

Our recently published Phys. Rev. B Rapid Communications paper (2017) on an experimental and theoretical study of the indirect gap optical absorption in bulk Ge has been further developed to give a detailed derivation of the resonant absorption model in various approximations as well as details of our optical transmittance and reflectance experimental data covering the entire spectral range between the indirect and direct gap. It is shown that when the intermediate states are assumed with constant energy, the result of the absorption coefficient is in disagreement with experiment. When the model is improved by taking into account the energy dependence of the intermediate states, but without using any adjustable parameter, the photon-energy dependence of the absorption coefficient is in very good agreement with experiment. In order to produce full agreement with experimental data, it is necessary to include both the Elliott excitonic effects together with the Hartman energy dependence theory of the intermediate states into the full resonant enhancement theory that has been developed here (see Figure 4 below). This work has been accepted for publication in Physical Review B (2018).

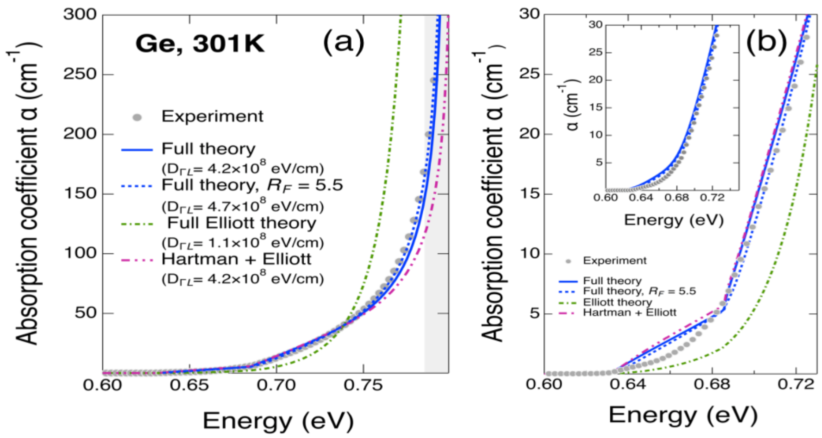


Figure 4. Comparison of the experimental and theoretical absorption coefficient of Ge in the spectral range between the indirect and direct band gaps using theories proposed by Hartman and by Elliott and the generalized theory developed in this study using independently determined band structure parameters.

For further information, contact Joanne Zwinkels, 613-993-9363 (joanne.zwinkels@nrc-cnrc.gc.ca)

We have further analyzed the intense photoluminescence (PL) spectra that we measured for a large number of $Si_{1-x}Ge_x$ epitaxial layers grown by molecular beam epitaxy at energies from 600 to 1100 meV. It has been shown that the previously unexplained broad PL peak can be assigned to Ge nanocrystals (NCs) self-assembled within the SiGe layers. These NCs are assumed to be lattice matched to the SiGe in the vertical, growth direction. A consequence of this assignment is that, as the Ge-fraction in the SiGe layer increases, the vertical strain in the NCs changes from compressive to tensile at x ~ 0.36, lowering the NC band gap (BG) below that of bulk Ge. The PL results for more than 60 samples exhibiting this broad PL peak were examined to determine how they followed the strained Ge BG for x from 0.05 to 0.53. The PL is resolvable as two narrower peaks separated by the momentum conserving phonon energy for Ge. Strain and confinement shifted NC bound exciton energies calculated numerically agree well with the measured ones. When Raman scattering results were examined for some of the same samples, the phonon mode frequencies obtained provided valuable corroborative evidence for the presence of the Ge NCs.

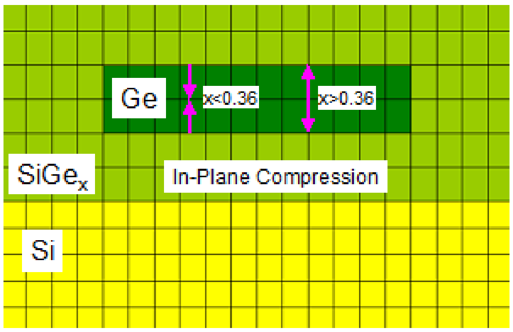


Figure 5a. Cross sectional schematic for the x-z plane of lattice matched Ge NCs within SiGe on Si(001).

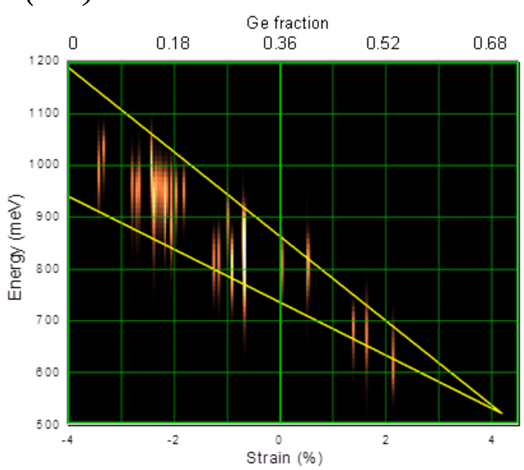


Figure 5b. PL energy distributions for the broad PL versus the uniaxial vertical strain in the Ge NCs assumed to be present in the $Si_{1-x}Ge_x$ layers. The upper and lower solid lines are the direct and indirect bandgap energies for Ge calculated using deformation theory for uniaxial strain. The top horizontal scale is Ge fraction (x) from which the bottom scale strain values are derived.

For further information, please contact: Nelson Rowell, 613-993-2377 (nelson.rowell@nrc-crnc.gc.ca)

NRC's New Absolute Diffuse Reflectance Scale: Update

A new monochromator-based absolute reflectometer is being developed at NRC to realize an absolute diffuse reflectance scale in a d:0 geometry in the UV-VIS-NIR range. The design and construction of this instrument has been completed. This includes the fabrication of all of the optomechanical components and a custom 20-cm diameter PTFE integrating sphere accessory based on the modified Sharp-Little method. A schematic drawing of the instrument components is shown in Figure 6. The detailed characterization of the instrument is in progress. To-date, preliminary measurements of the PMT nonlinearity and the wavelength scale and spectral bandpass uncertainty have been carried out. It is planned to use this new reference instrument for the 2nd round CCPR K6 (spectral diffuse reflectance) comparison which is scheduled to begin in the Fall of 2019.

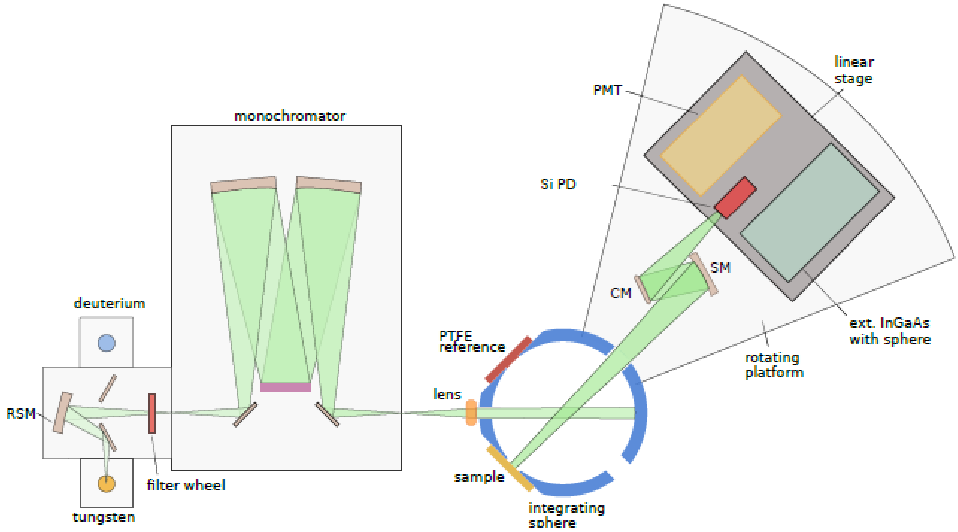


Figure 6. Schematic drawing of new NRC absolute reflectometer (RSM = rotating spherical mirror; CM = cylindrical mirror; SM = spherical mirror)

For further information, please contact: Luke Sandilands, 613- 990-8990 (luke.sandilands@nrc-cnrc.gc.ca) or Joanne Zwinkels, 613-993-9363 (joanne.zwinkels@nrc-cnrc.gc.ca)

UPCOMING IES MEETINGS CALENDAR

The Illuminating Engineering Society (IES) is sponsoring the following meetings and conferences in 2019:

LIGHTFAIR International
May 21-23, 2019 (Pre-Conference, May 19-20)
Philadelphia, PA
www.lightfair.com

2019 IES Annual Conference
August 8-10, 2019
Louisville, KY
www.ies.org/events/annual-conference

2019 IES Street and Area Lighting Conference
September 22-25, 2019
San Diego, CA
www.ies.org/events/street-area-lighting-conference

2019 Annual IES Aviation Lighting Committee Fall Technology Meeting
October 19-25, 2019
Monterey, CA
www.iesalc.org/technology-meetings

NEWS FROM THE CIE

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

Upcoming Events

CIE 2019 29th Quadrennial Session
June 14-22, 2019 – Washington, DC
http://www.cie.co.at/news/cie-2019-29th-quadrennial-session

CIE Australia Lighting Research Conference -- CALReCo2019
February 12, 2019 – Sydney, Australia
http://www.cie.org.au/calreco2019.html

New Publications

CIE 015:2018 Colorimetry, 4th Edition
http://www.cie.co.at/publications/colorimetry-4th-edition

CIE 198-SP2:2018 Determination of Measurement Uncertainties in Photometry Supplement 2: Spectral Measurements and Derivative Quantities
http://www.cie.co.at/publications/determination-measurement-uncertainties-photometry-supplement-2-spectral-measurements

DIS 026/E:2018 CIE System for Metrology of Optical Radiation for ipRGC-Influenced Responses to Light
http://www.cie.co.at/publications/cie-system-metrology-optical-radiation-iprgc-influenced-responses-light

CIE 229:2018 Groundwork for Measurement of Effective Intensity of Flashing Lights
http://www.cie.co.at/publications/groundwork-measurement-effective-intensity-flashing-lights

CIE x045:2018 Proceedings of CIE 2018 "Topical Conference on Smart Lighting" 26 – 27 April 2018, Taipei, Chinese Taipei
http://www.cie.co.at/publications/proceedings-cie-2018-topical-conference-smart-lighting-26-27-april-2018-taipei-chinese

For information on all of the CIE technical publications, visit:
http://www.cie.co.at/publications

OTHER NEWS…

ASTM Standard E308-18 Published

This document, "Standard Practice for Computing the Colors of Objects by Using the CIE System," provides the values and practical computation procedures needed to obtain CIE tristimulus values from spectral reflectance, transmittance, or radiance data for object-color specimens. For more information, visit: https://www.astm.org/Standards/E308.htm

Industry Leaders Chart Path Forward for the Future of Lighting at LRC Annual Conference

The lighting industry continues to be in a state of rapid transformation. New technologies and new business models are forcing the industry to rethink what it means to be a lighting company in the 21st century. To understand and address this issue, the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute brought together leaders from the lighting industry, policy makers, and business development experts for its annual Partner's event on September 5-6, 2018 in Troy, New York. For more information, visit:
https://www.lrc.rpi.edu/resources/newsroom/pr_story.asp?id=410

LRC Releases Report on LED Horticultural Lighting Systems

The Lighting Research Center (LRC) at Rensselaer Polytechnic Institute has published a new report on the energy and economic performance of LED horticultural luminaires. The LRC evaluated key factors such as power demand, life-cycle cost, luminaire intensity distribution, and luminaire shading. Of particular importance is the fact that the LRC considered the effectiveness of the entire lighting system for a controlled growing environment. For more information:
https://www.lrc.rpi.edu/resources/newsroom/pr_story.asp?id=396

Web-Based Educational Modules on Roadway Lighting

In the past decade, roadway lighting technologies have advanced rapidly with the development of light-emitting diode (LED) systems, adaptive lighting controls, and an increase in knowledge about the ways roadway lighting can affect safety, perception and even circadian rhythms. These advancements have resulted in many new questions about the appropriate use, design and implementation of roadway lighting. In response, the Federal Highway Administration (FHWA) commissioned the development of free, online modules containing the latest information about roadway lighting. To access the modules, visit:
https://safety.fhwa.dot.gov/roadway_dept/night_visib/roadway_lighting_workshop/

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

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