COUNCIL FOR OPTICAL RADIATION MEASUREMENTS

Pressing Problems and Projected National Needs in Optical Radiation Measurements

MARCH 2020

www.cormusa.org

INTRODUCTION

The Council for Optical Radiation Measurements (CORM, www.cormusa.org) is a not-for-profit, international organization consisting of members from industry, academia and government who are interested in the measurement of optical radiation (light, ultraviolet and infrared energy), color and optical properties of materials. CORM began as a subcommittee of the Commission Internationale de l'Éclairage (CIE) for the purpose of advising national metrology institutes (NMIs) working in photometry, radiometry and colorimetry about the needs within these communities for standardization, calibration sources, and measurement procedures and techniques.

Periodically, CORM has published reports containing the results of surveys of its members (excluding those individuals from NMIs) and summarized the results of those surveys to assist NMIs including the National Institute for Standards and Technology (NIST) in the U.S., National Research Council Canada (NRCC), Centro Nacional de Metrología (CENAM) in Mexico, the National Physical Laboratory (NPL) in the U.K., and others in developing programs to best assist industry, academia and practitioners in the measurement of optical radiation.

The previous report, the CORM Eighth Report, was published in 2016, 15 years after the publication of the CORM Seventh Report in 2001. At the time of publication of the Eighth Report, advances in solid state lighting technology, measurement instrumentation and knowledge about the visual and nonvisual impacts of light and other optical radiation were moving so quickly that CORM decided to prepare shorter, more frequent reports in order to be as responsive to the needs of CORM membership and NMIs as possible.

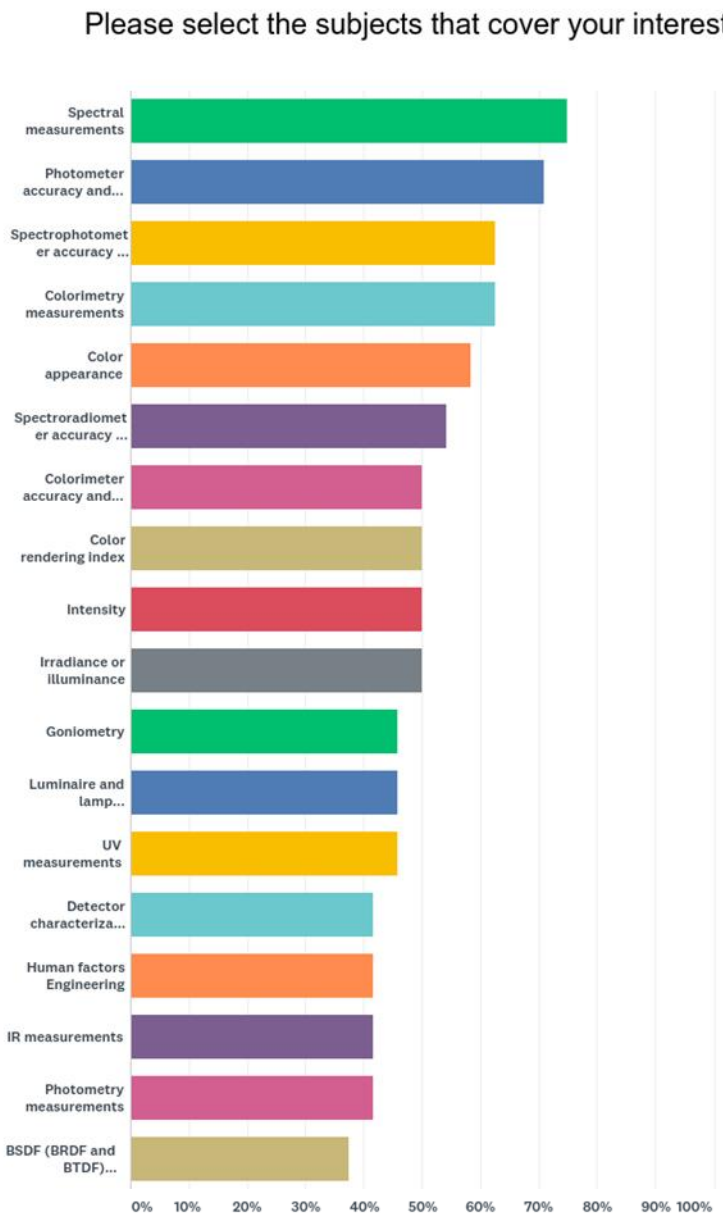
In 2018, CORM carried out a survey of membership consisting of several short questions:

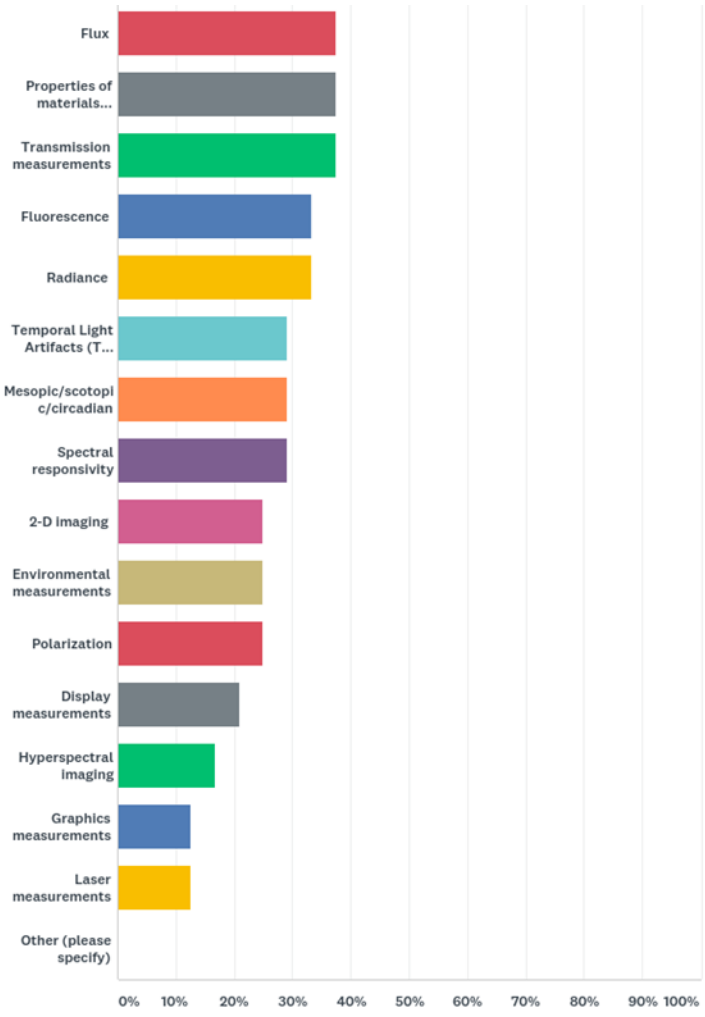
- What subjects cover your interests in optical radiation measurement?
- What kind of optical radiation artifacts/products/hardware do you measure or calibrate now?
- What calibration or other services are needed that are not currently available from the NMIs?
- What challenges in optical radiation measurement and/or calibration do you face or anticipate?
- What are your needs in the areas of accreditation and measurement traceability?
- What are your needs for documentary standards or guidelines?

Twenty-four individuals completed the survey. The following sections of this report address the responses to each question. Except for the first question (to which respondents selected items from a list of possible answers), responses to the questions were answered in a free-form text box online. Word clouds summarizing the collective responses were generated with the sizes of words proportional to their frequency among the answers as a guide in interpreting the responses. A short summary of responses for each question follows the word cloud diagrams.

Please select the subjects that cover your interests.

For this question, respondents selected one or more answers from a list of topics. Top answers:



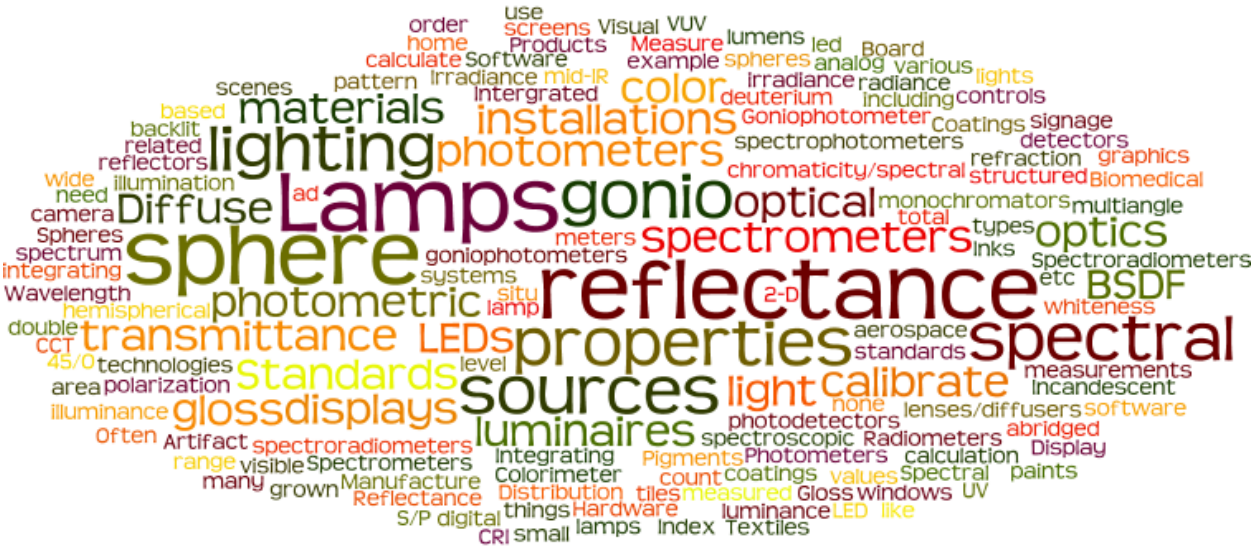


Conclusions: Top interest indicates subjects of interest are related to spectral measurements and calibration, photometric measurements and calibrations, Intensity and illuminance measurements and calibrations. Additionally, the CORM mission is still valid as the topics of interest intersect substantially with those that CORM addresses in its technical conferences and meetings.

What kind of optical radiation artifacts/products/hardware do you measure or calibrate now?

Top responses:

1. Lamps / sources / lighting
2. Reflectance
3. Spectral
4. Sphere
5. Gonio(photometric/photometer)



Summary: Responses to this question were diverse and included many different aspects of photometry and radiometry. Characterizing sources for lighting and other applications is a primary activity. Specific characteristics of substantial interest include sphere (lumen output) measurements, spectral measurements, and intensity distributions (goniophotometric measurements). Properties of materials such as reflectance were also commonly specified.

What calibration or other services are needed that are not currently available from the National Metrology Institutes?

Top responses:

1. None
2. Reflectance/scatter
3. Spectral calibrations
4. Flicker and other new metrics

Summary: The most frequent response was that NMIs were providing the necessary services. Additional services or calibrations involving the reflectance (or scatter) measurement of materials were frequently measured, as well as spectral calibrations (out to 3000 nm), and measurement/calibration services dealing with new metrics for light sources that address human responses, such as flicker or other aspects.

What challenges in optical radiation measurement and/or calibration do you face or anticipate?

Top responses:

1. Need for new physical standards (LEDs)
2. Needs for new measurement standards/procedures (new instruments)
3. Development of new metrics with new spectral/spatial/temporal properties
4. Traceability
5. Measurement of color/appearance

Summary: The transition from filament-to semiconductor-based (or other) measurement standards presents a source of anxiety. Evolution in sensor/instrumentation technology will require new methods for measurement. Evolving knowledge about vision and other human responses will also impact what needs to be measured. Traceability of measurements to a trustworthy source remains a concern.

What are your needs in the areas of accreditation and measurement traceability?

Conclusions and comment summaries:

1. No major issues with areas of accreditation or measurement traceability.
2. Some comments related to need for traceable standards:
    a. Oxygenation measurements;
    b. Low cost spectral standards (non-high precision);
    c. BSDF reference standards.
3. Some respondents noted that spectral source uncertainty reductions are needed to reduce disagreements between labs performing measurements on the same or similar products.
4. One comment related to the desire for lower cost (non-high precision) spectral calibration standards with a 5-10nm resolutions.
5. One comment on the need for TLA calibration traceability [NEMA-77].

Comment on your needs for documentary standards or guidelines?

Conclusions and comment summaries:

1. TLA/TLM (i.e., flicker),
2. Colorimetry and uncertainty of measurements [spectroscopy],
3. Goniophotometry/near field Goniophotometry - calibration and uncertainty.

DISCUSSION

A primary concern of the survey respondents to CORM's Ninth Report questionnaire was the accurate measurement of spectral or color properties of light sources. Undoubtedly this is related to conti nuing developments in solid state lighting technology and especially in the growing proliferation of lighting quality metrics that take the spectral distribution of a source into account, including color rendering metrics, circadian photometry, and other visual and nonvisual responses.

The dependence in the past of standard lamps for photometric calibration using filament sources and the relative scarcity of these sources following energy legislation and industry trends that have led to the phasing out of incandescent lamps has also increased concerns about the use of light emitting diode (LED) sources as calibration standards. LEDs are dependent upon thermal conditions for their output and can be highly sensitive to changes in forward current or manufacturi ng tolerances in a way that can result in substantial variations in output and spectral content, even for nominally equal measurement conditions. This is an area where assistance from NMIs will continue to be critical.

There also seems to be a growing inte rest in proper methods for measuring the optical properties of materials such as their reflectance, light-scattering properties and gloss.

Finally, given the rapid growth of LED and other solid state lighting technologies that can change light output very rapidly, the importance of temporal fluctuations in light output that create flicker leading to stroboscopic effects and other forms of temporal light artifact (TLA) is also increasing. Measurement protocols for assessing and quantifying flicker accurately and in a repeatable manner will be necessary as these properties continue to be reported in lighting product data sheets.

CORM has been evaluating the frequency and scope of CORM Reports in the future. At present, CORM Reports are published approximately once every five to seven years. One possibility would be to develop questionnaires focused on specific topics and publishing reports with greater frequency. It is expected that the number of responses to questionnaires in these reports might be smaller, bu t a higher rate of response might be found if the burden of completing the questionnaire were lower. Comments on this issue from readers are welcome and can be submitted online at: http://cormusa.org/contact-us.