

Title: First development of normalisation on BRDF based quantities

Abstract

The commercial success of a product can sometimes be dependent on the aesthetic appearance of that object. For this reason, commercial organisations are continuously looking to develop new attractive visual effects. The control and characterisation of these effects requires the development of a traceability chain based on the Bidirectional Reflectance Distribution Function (BRDF). Primary references and standard artefacts have recently been established at the NMI level and commercial measurement devices have also been developed. However, the field of BRDF measurements is still suffering from the lack of standardisation. Proposals in response to this SRT should address this issue by developing, in the framework of CIE normative activity, recommendations for the measurements of BRDF, gloss and goniochromatism.

Keywords

Gloss, goniochromatism, iridescence, BRDF, colour, appearance.

Background to the Metrological Challenges

Within the last 20 years, substantial effort has been made by industrial manufacturers to create attractive and sophisticated visual effects, typically using metallic paints, goniochromatic pigments, deep matt finishes, fluorescent agents, sparkle or other pearlescent or grainy effects. Classical colorimeters or glossmeters, with their fixed geometries, are not adequate for characterising these effects.

Manufacturers of spectrophotometer systems are currently developing a new generation of instruments with an increased number of fixed measurement geometries (called multi-angle spectrophotometers) or devices with the possibility to scan across arbitrary geometries using rotating stages (called goniospectrophotometers). Both types of devices work typically in relative mode, by comparing the measured signal from the sample against that from a calibrated standard.

In terms of normalisation in the field of spectrophotometry, there are currently no activities taking place at the European level (i.e. there is no CEN TC dealing with spectrophotometry). All work is done at the international level, in particular by the CIE (Commission Internationale de l'Eclairage). CIE emphasises the need, provides the international forum for discussion and delivers standards, guidance and procedures that can become international and national standards.

In July 2011 and May 2012, the CIE opened respectively two reporterships:

- R1-53 "Gloss Perception and Measurement"
- R2-72 "Multigeometry color measurement of effect materials and metrics for evaluation"

In 2014, both reports pointed out the need of standardisation. In 2015, CIE Div 2 activity report pointed out the need of new metrics on the topic of BRDF and appearance.

In 2013, ASTM published standard E2175-01, "Standard Practice for Specifying the Geometry of Multiangle Spectrophotometers" showing the importance of the subject from the US point of view.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on metrology research necessary to support standardisation in BDRF based quantities for visual appearance of materials.

The specific objectives are

1. To propose standard parameters for the measurement of the Bidirectional Reflectance Distribution Function (BRDF) of particular materials and optical surfaces in order to improve the traceability between users and NMI (National Metrology Institutes), and therefore to allow for better agreement between commercial goniospectrophotometers.
2. To propose a minimum set of angular geometries for the characterisation of the full BRDF of goniochromatic visual effect pigments.
3. To propose a new method for gloss measurement that correlates with the visual perception. The method should be based on reflectance measurements, on visual evaluations and on the definition of a standard observer.
4. To facilitate the take up of the technology and measurement infrastructure developed by the project by the instrument manufacturers and by the industries for which the appearance of the product is of high importance (automotive, cosmetics, pigments, packaging).

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Standards Developing Organisation or by a letter signed by the convenor of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMRP project IND52 XDRreflect and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.4 M€, and has defined an upper limit of 0.5 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project. Any deviation from this must be justified.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the materials and spectrophotometer manufacturing sectors.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”.

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased

- organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.