

CIE Online Tutorials on Colorimetry and Visual Appearance

TUTORIAL ON THE MEASUREMENT OF ADVANCED BRDF

Convener: Dr Gaël Obein (gael.obein@lecnam.net)

Summary

BRDF is the quantity that fully describes the reflection of light on the surface of an object. Therefore, BRDF is relevant for questions where “appearance” is involved. This tutorial on BRDF is dedicated to scientists who know about reflectance and BRDF measurements, but are not experts in it. The objective is to focus on particular points that are not well known, but can lead to large measurement errors and disappointments, namely "polarization" and "specular". The tutorial will end with an overview on what is expected from BRDF measurements in industries that are largely concerned with appearance: the Automotive and the Cosmetics Industry.

CIE Related Publications and Current Work

- TC 2-85 Recommendation on the geometrical parameters for the measurement of the Bidirectional Reflectance Distribution Function (BRDF)
- JTC 12 (D2/D1/D8) The measurement of sparkle and graininess
- JTC 17 (D1/D2/D8) Gloss measurement and gloss perception: A framework for the definition and standardization of visual cues to gloss
- CIE 175:2006 A framework for the measurement of visual appearance.
- CIE 130-1998 Practical Methods for the Measurement of Reflectance and Transmittance.
- Research strategy topic:
 - Visual Appearance: Perception, Measurement and Metrics
 - Reproduction and Measurement of 3D Objects

Presentations

- **Reflectance and BRDF measurements – let’s start with good basics**
Annette Koo, MSL, New Zealand
 - Definition of quantity
 - Introduction to the typical “shapes” & representation modes
 - Review of latest developments
- **BRDF and polarization: pitfalls – and how to avoid them**
Tatjana Quast & Alfred Schirmacher, PTB, Germany
 - Polarization effects in BRDF measurement (according to the type of sample, the type of polarization, the type of illumination and the detection used)
 - Practical advice on how to cope with these effects
- **BRDF in the specular, don't be naïve**
Gaël Obein, LNE-Cnam, France

When trying to evaluate glossiness, the first reflex is to access the specular peak. However, the high dynamic of BRDF in this area can only be measured with care, including high angular resolution and high dynamic that can lead to face light coherence effects.

- **BRDF in automotive industry, what for**

Benoit Deschamps & Stéphane Régnier, Renault group, France

The Automotive Industry has been the first user of BRDF measurements in order to control, formulate and render appearance of car painting. They are still motor of innovation in this field. This talk will address its use and the biggest challenges facing the industry in terms of bi-directional spectrophotometry.

- **BRDF in cosmetic industry, what for**

Silvia Morim Santos & Maria Ortiz, L'Oréal Research, France

The Cosmetics Industry is a dynamic and global industry sector, concerned with physical appearance and its control. However, the specificities and the variability of skins are not ideally adapted to BRDF measurement. That is why the Cosmetics Industry is now moving to BRDF for research on new effects and digital simulations that may request new metrological developments.

Overview

Topic	Length	Presenter
Reflectance and BRDF measurements – let's start with good basics	20 min	Annette KOO
BRDF and polarization: pitfalls - and how to avoid them	20 min	Tatjana QUAST Alfred SCHIRMACHER
BRDF in the specular, don't be naive	20 min	Gaël OBEIN
BRDF in automotive industry, what for?	15 min	Benoit DESCHAMPS Stéphane REGNIER
BRDF in cosmetic industry, what for?	15 min	Silvia Morim SANTOS Maria ORTIZ

Presenters

Benoît Deschamps



Research Engineer in computer graphics & visual simulation at Renault Group, Guyancourt, France

In 2002, **Benoît** earned a Master's degree in "Informatique & MultiMedia" from the University of Bordeaux 1 in France.

Currently Benoît is in charge of computer-generated imagery solution for engineering use cases. From 2002 to 2006 he was responsible for the development of tools to validate car paint at Renault (colour validation, colour gap, orange peel, and aging). From 2006 to 2016 he accounted for the co-ordination of computer-generated Imagery Solutions & Systems at PSA Group (physical based rendering, modelling, and visualization).

Since 2016, he has been working for Renault group to challenge the physical mock-up with physical based rendering approach from measurement tools to displaying computer-generated imagery.

Dr Annette Koo



Principal Research Scientist at the Measurement Standards Laboratory of New Zealand (MSL), Lower Hutt, New Zealand

Annette has been working as a Research Scientist at New Zealand's National Metrology Institute since 2008, developing expertise in the measurement of light and human perception.

Her work includes the design of a goniospectrophotometer and piloting the CCPR comparison of spectral transmittance.

Dr Silvia Morim Santos



Head of Optical Characterization Laboratory, L'Oréal Research & Innovation, Aulnay, France

Silvia has been working at R&I L'Oréal since 2013. She obtained her PhD in spectroscopy of single-walled carbon nanotubes from the University of Bordeaux in France. She also holds a Diploma in Physics from the University of São Paulo (Brazil), a Diploma in General Engineering from Ecole Polytechnique (France) and a Diploma in Optics Engineering from L'Institut d'Optique Graduate School (France).

Her current interests are in the optical characterization of ingredients and simplex cosmetic formulas.

Dr Gaël Obein



Associate Professor at National Conservatory of Arts and Crafts (Cnam), Paris, France

Gaël has been working for 20 years in the field of goniospectrophotometry, with a particular interest in measurement devoted to the characterization of gloss. He is Head of the Research Department on Radiometry and Photometry at LNE-CNAM.

Presently, Gaël is co-ordinator of two European research projects, JRP BiRD ("Bidirectional Reflectance Definitions") and JRP BxDiff ("New quantities for the measurement of appearance"), carried out in the frame of the EURAMET EMPIR programme. He also is president of CIE-France, chair of TC 2-85 and co-chair of JTC 17.



Dr Maria Ortiz Segovia

Research Engineer at Digital Department, L'Oréal Research & Innovation, Aulnay, France

Maria is a Research Scientist with a strong background in image processing. She has worked on different projects related to image quality, colour imaging, image reproduction and security.

Her recent activities are based on appearance reproduction and the acquisition of materials for printing and cosmetology applications. She has been actively engaged with the IS&T and SPIE societies since 2011. She joined L'Oréal in July 2019.



Dr Tatjana Quast

Research Scientist at the Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

Tatjana is a Research Scientist with a strong background in optics. She has worked in different fields of research, including femtosecond laser pulse shaping and spectroscopy, interferometric length measurement and reflectometry of special-effect coatings. She has been with PTB's working group "Reflection and Transmission" since 2015. Her current interests include diffuse transmission and polarization effects in diffuse reflectometry. She is a member of CIE JTC 12.



Stéphane Régnier

Senior expert for virtual mockup at engineering and design departments of Renault Group, Guyancourt, France

Stéphane received an engineering degree in computing science from Institut National des Sciences Appliquées in Lyon in 1990. He has been involved in the development of visualization software, simulation tools and virtual reality applications across departments in the areas of R&D, Design and Engineering at Renault since the early 90s. He has managed several R&D teams and has long-standing experience with virtual reality and 3D visualisation.

One of his more recent focus is the development of visual simulation domain at Renault, for which material measurement is key.



Dr Alfred Schirmacher

Head of group "Reflection and Transmission" at the Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

Alfred is a physicist with 30 years' experience in the fields of spectrometry and radiometry. He leads the lab "Reflection and Transmission" at PTB that deals with research and calibration work for applications of regular and diffuse quantities.

He has long-time expertise in standardization work, with more than 17 years' experience in ISO & CEN on eye-protection. He is active in DIN FNF on Colour and DfwG (Deutsche farbwissenschaftliche Gesellschaft), where he leads the working group 'Multigeometry'.

Alfred is a member of CIE TC 2-85 and CIE JTC 12.