



xD-Reflect

"Multidimensional Reflectometry for Industry"

a research project of the European Metrology Research Program (EMRP)

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Overview:

- The European EMRP Programme
- xD-Reflect in short,
the different Work Packages
- WP1 “Goniochromatism“

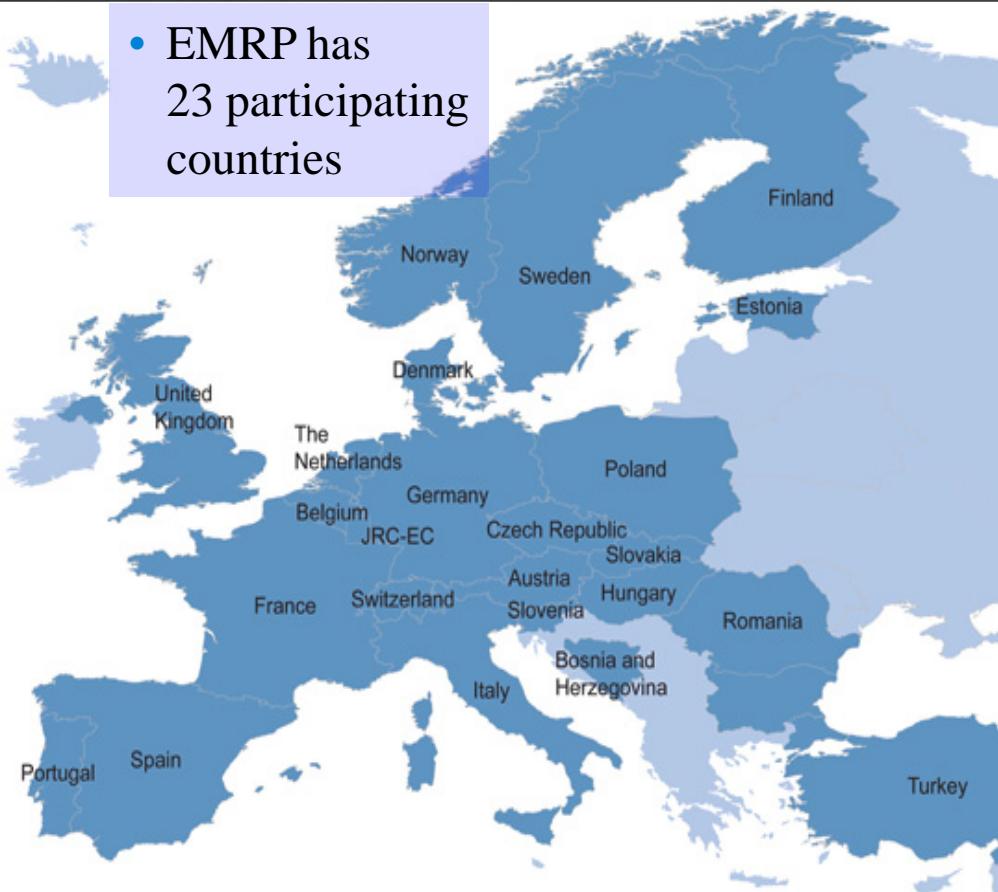


- The European Metrology Research Programme (EMRP) is jointly supported by the European Commission and the participating countries within the European Association of National Metrology Institutes (EURAMET).
- The EMRP enables European metrology institutes, industrial organizations and academia to collaborate on joint research projects within specified fields.
- The EMRP is supported by the European Union and has a value of 400 M€





- EMRP has 23 participating countries



- As a minimum 3 European NMIs has to join for a proposal

- Austria
- Belgium
- Bosnia and Herzegovina
- Czech Republic
- Denmark
- Estonia
- European Commission
- Finland
- France
- Germany
- Hungary
- Italy
- The Netherlands
- Norway
- Poland
- Portugal
- Romania
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom



xD-Reflect: Consortium members

Funded Partners:

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MIKES

CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS



REG's:

KU LEUVEN



Universitat d'Alacant
Universidad de Alicante



Unfunded Partner:



REG: Research Excellence Grant, financial support for research not located at an NMI



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xD-Reflect: Web page

- Project start:
September 2013

- Visit our web page at:
www.xdreflect.eu



The screenshot shows the xD Reflect website homepage. At the top, there is a logo for "JRP - IND 52" with a green circle and a rainbow-colored beam. Below it is the "xD Reflect" logo. To the right, the text "MULTIDIMENSIONAL REFLECTOMETRY FOR INDUSTRY" is displayed. A navigation bar below the logo includes links for Home, Summary, Project, Partners, Member Area, and News. A search icon is also present. The main content area features a section titled "xD Reflect" with a brief description of the project's goal: "The Joint Research Project „Multidimensional reflectometry for industry“ aims to validate reliable optical measurements with traceability to the SI-system to describe the overall macroscopic appearances of modern surfaces." Below this text is a photograph showing a robotic arm positioned over a circular conveyor belt with various colored samples. Another photograph shows a product with a metallic, reflective surface. To the right, there is a sidebar with the EURAMET logo, information about the EMRP (European Metrology Research Programme), and a "Recent Posts" section with links to the "2nd JRP Meeting" and "News".

MULTIDIMENSIONAL REFLECTOMETRY FOR INDUSTRY

xD Reflect

The Joint Research Project „Multidimensional reflectometry for industry“ aims to validate reliable optical measurements with traceability to the SI-system to describe the overall macroscopic appearances of modern surfaces.

Objects can be identified through visual surface attributes such as colour, gloss, texture, transparency, graininess or sparkle. The compilation of these visual attributes gives **the appearance of the surface**. The appearance of a product is important for several industries, e.g. automotive, cosmetics, paper, printing, packaging, coatings, plastics, steel industries, etc. because it is frequently one of the most critical parameters affecting customer choice.

For this reason, since 20 years, a lot of efforts have been conceded by the manufacturers to propose new and sophisticated visual effects, like metallic paintings, gonioreflectrometry, deep matt finishes or sparkle effects for instance.

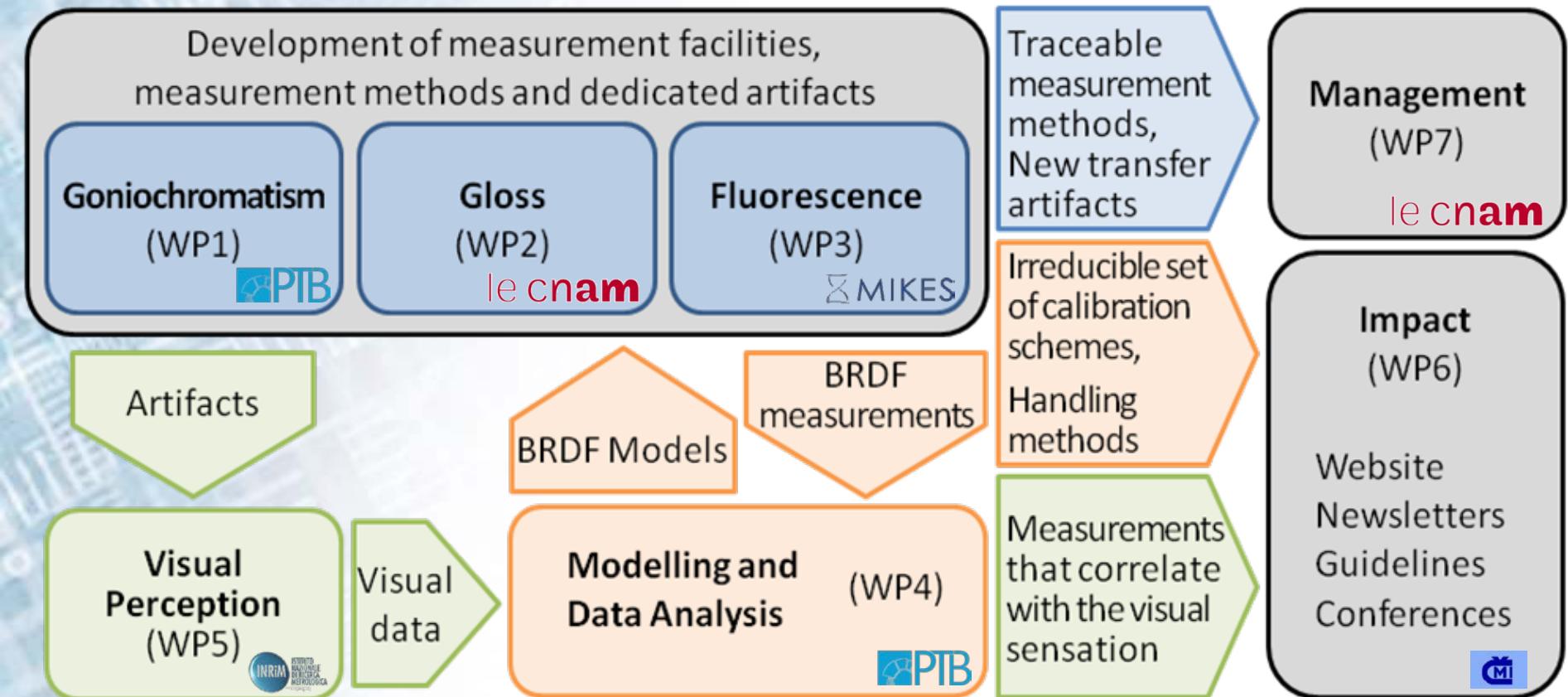
Recent Posts

2nd JRP Meeting

News



xD-Reflect: Structure of the project



xD-Reflect: The work packages

WP1: Goniochromatism

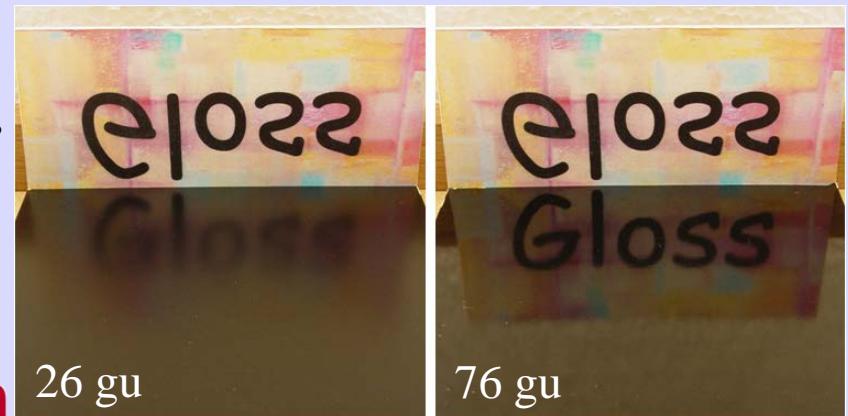
- Enhance the spectral and spatial resolution of reference gonioreflectometers developed by each participant, using modern detectors, conoscopic optical designs, CCD cameras, line scan camera, modern light sources



WP2: Gloss

- Propose a new standard and recommendations for gloss measurements, that take into account the visual perception, the background and is adapted to modern surfaces

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xD-Reflect: The work packages

WP3: Fluorescence

- Development of traceable facilities, methods, and reference materials that can be used to improve the uncertainties of appearance measurements of surfaces with fluorescent materials

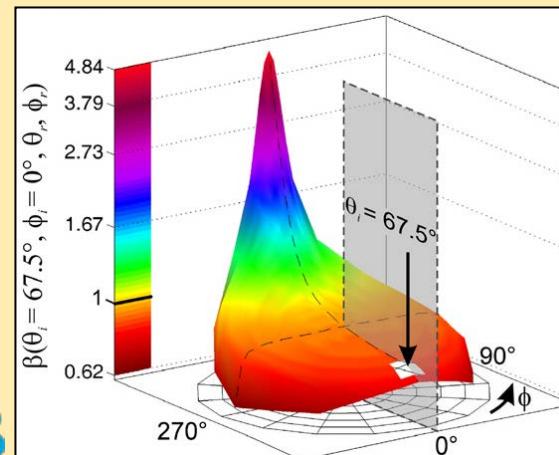
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WP4: Modelling and Data Analysis

- Development of appropriate modelling approaches and uncertainty evaluation schemes for multidimensional reflectometry

 PTB

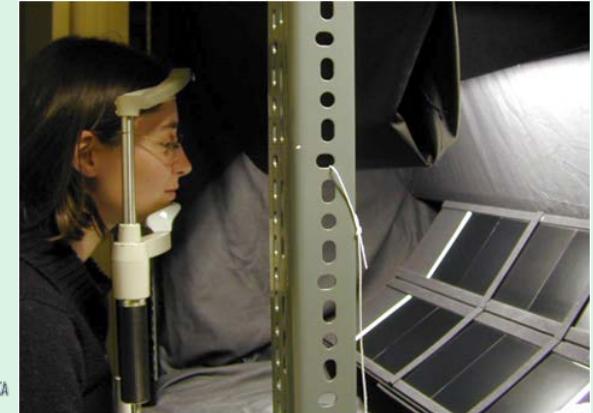




xD-Reflect: The work packages

WP5: Visual Perception

- Provide a synthesis between the visual attributes and their metrological characterisation
- Build reference systems and improve the parameteric definitions of visual attributes
- Correlate visual intensity response stimuli to material characteristics and environment attributes



WP6: Creating Impact

- The aim of this workpackage is to ensure that the results achieved by the project are adequately and appropriately communicated to the stakeholders and end-user community and that input and feedback is obtained from this community
- Web page, Newsletter, Conferences, Guidelines

The xD Reflect project aims to establish reliable optical measurement with traceability to the 5-system to describe the overall macroscopic appearance of modern surfaces. Objects can be assessed through visual surface attributes such as colour, gloss, texture, transparency, graininess or sparkle. The combination of these visual attributes gives the appearance of the surface. The appearance of a product is important for several industries, e.g. automotive, food, paper, cosmetics, packaging, pharmaceuticals, construction, and industries, etc. because it is frequently one of the most critical parameters affecting consumer choices. For this reason, since 20 years, a lot of efforts have been conducted by the manufacturers to propose new and sophisticated visual effects, like metallic paintings, glossy lacquers, deep matt finishes or sparkle effects for instance.

In addition to the field effect, that means that reflectometry measurement will be accompanied by specific databases and protocols developed within the project, to be the basis for future international standards.





xD-Reflect: Project meetings

- Kick-off meeting with the whole scientific consortium
Paris, September 2013



JRP xDReflect - Kick off meeting - La Plaine St Denis, France - 17/18 September 2013



xD-Reflect: Project meetings

- 2nd project meeting, with industrial participation
(31 attendees), Braunschweig (Germany), January 2014





xD-Reflect: WP1 “Goniochromatism”

Development of measurement facilities,
measurement methods and dedicated artifacts

Goniochromatism
(WP1)

Gloss
(WP2)

Fluorescence
(WP3)

Traceable
measurement
methods,
New transfer
artifacts

Management
(WP7)

Artifacts

BRDF Models

BRDF
measurements

Visual
Perception
(WP5)

Visual
data

Modelling and
Data Analysis
(WP4)

Irreducible set
of calibration
schemes,
Handling
methods

Measurements
that correlate
with the visual
sensation

Impact
(WP6)

Website
Newsletters
Guidelines
Conferences



xD-Reflect: WP1 “Goniochromatism”

WP1 “Goniochromatism”

Task 1.1: Improvement of the traceability for standard goniometric geometries

Task 1.2: Extensive study of existing standard materials (multi-geometry, extended wavelength)

Task 1.3: Identification of a basic set of parameters for goniometric effects

Task 1.4: Data handling recommendation for goniochromatic materials

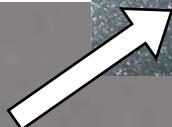
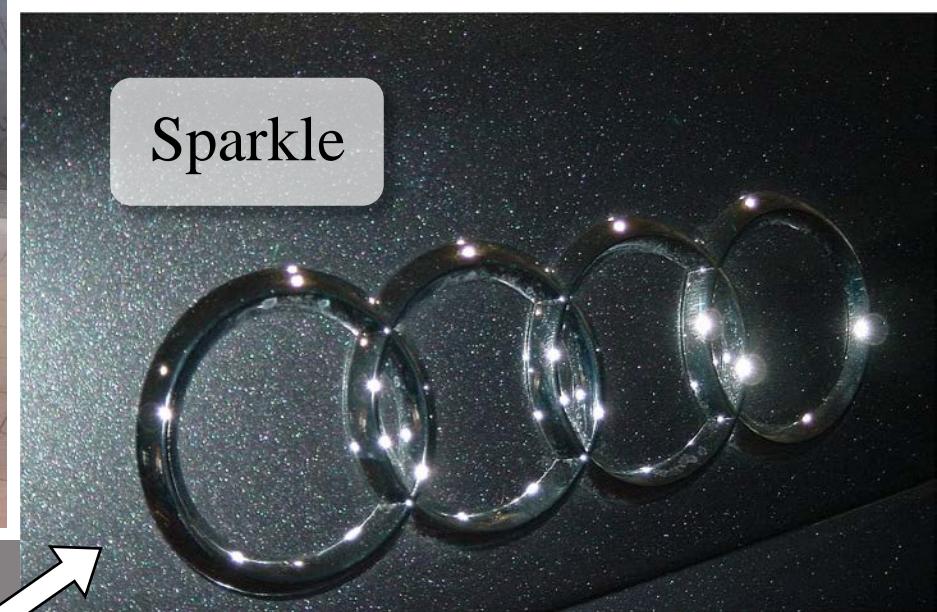
Task 1.5: Database for impact work package (multi-geometry, wavelength dependent)



“Goniochromatism“, Effect pigments



- Automotive





“Goniochromatism“, Effect pigments



- Cosmetics

Lip stick, lip balm, lip gloss,
eye shadow, mascara, rouge,
make-up grounding,
nail polish, etc.



“Goniochromatism“, Effect pigments



- Plastics and print industry





“Goniochromatism“, Effect pigments

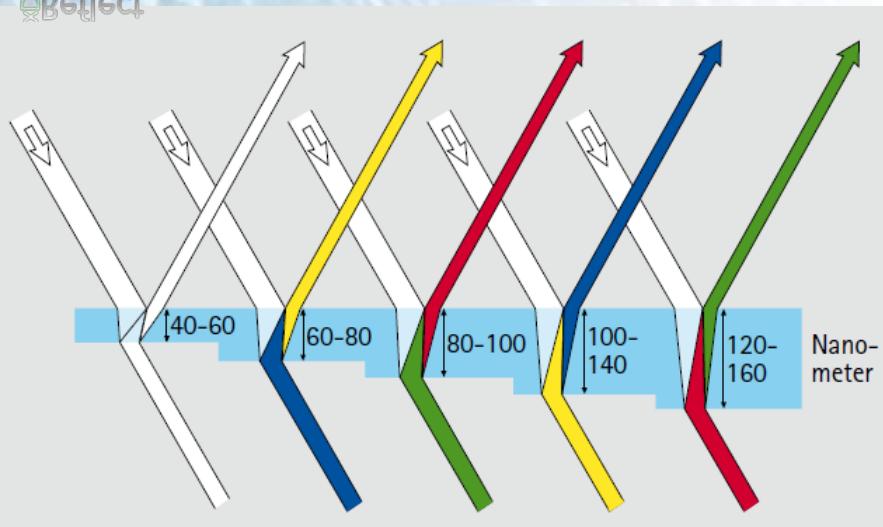


- Architecture
Surface refinement

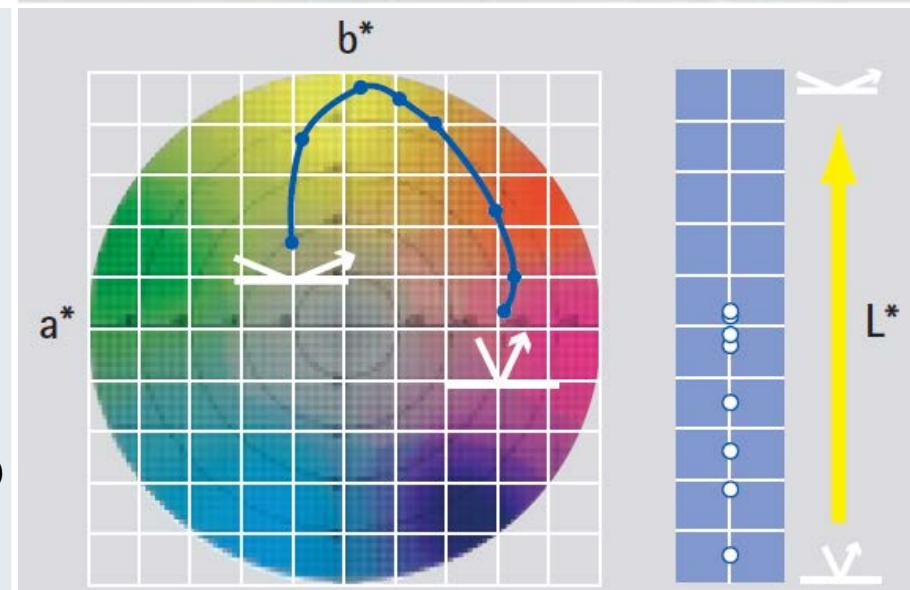
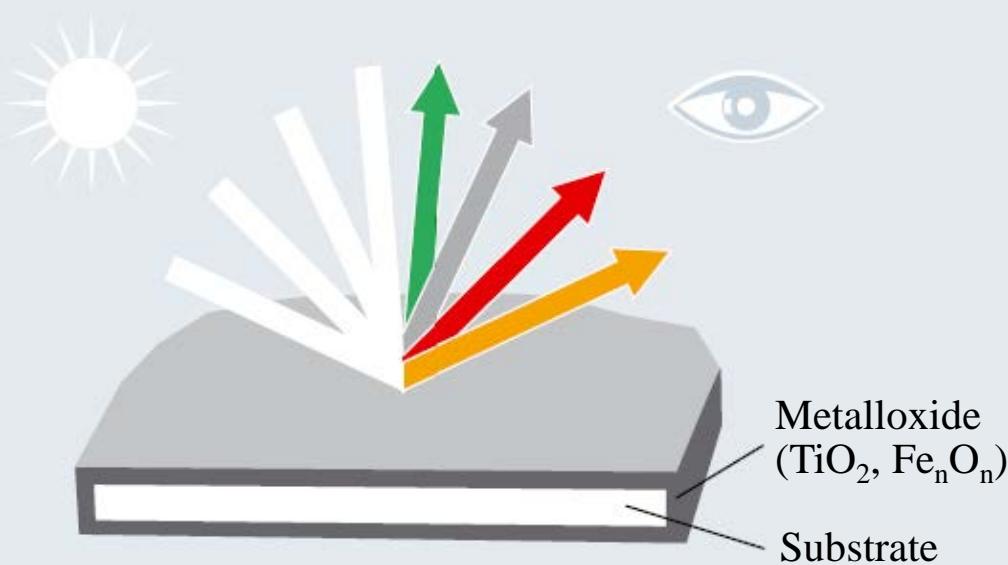
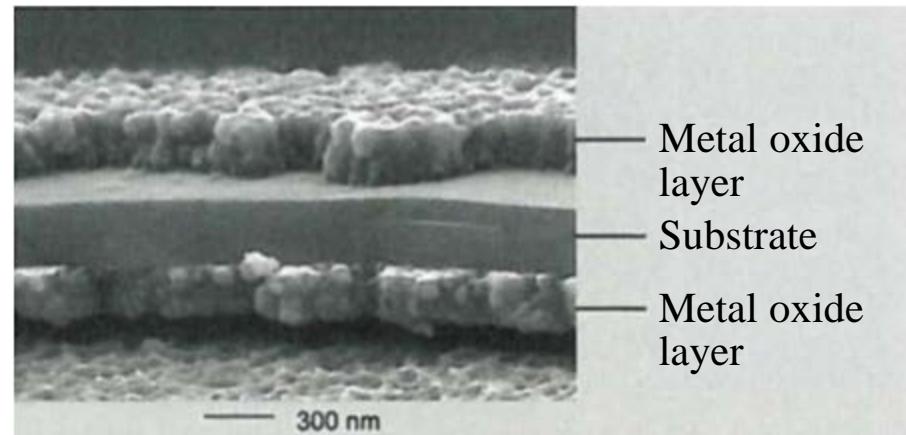
Office building, Braunschweig
Alucobond spectra colours



“Goniochromatism“, Effect pigments



- Particle sizes in the range 5 μm - 200 μm , thickness below 1 μm , aspect ratios up to 200





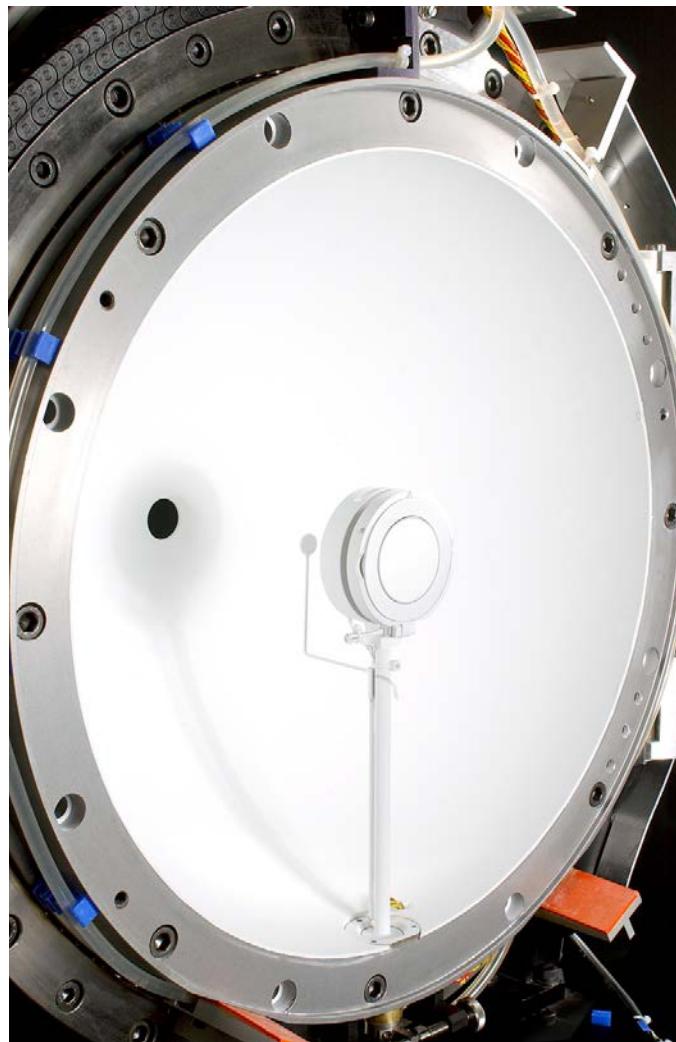
xD-Reflect: Traceability of instruments



CCPR-K5 (Sphere geometries)

Information

Metrology area, branch	Photometry and Radiometry, Photometry
Description	Spectral diffuse reflectance
Time of measurement	2001 - 2003
Status	Approved for equivalence, Results available
Reference(s)	Metrologia, 2013, 50, Tech. Suppl., 02003 CCPR-K5 Final Report, 2013, 181 pages CCPR-K5 Technical Protocol
Measurand	Spectral diffuse reflectance
Parameter(s)	Wavelength from 360 nm to 830 nm
Transfer device(s)	Three samples of Spectralon and three samples of matte white ceramic tile
Comparison type	Key comparison
Consultative Committee	CCPR (Consultative Committee for Photometry and Radiometry)
Conducted by	CCPR (Consultative Committee for Photometry and Radiometry)





xD-Reflect: Traceability of instruments

Improvement of the traceability for standard goniometric geometries

- In 2013 final results of CCPR-K5 “Spectral diffuse reflectance” (sphere geometries) were published,
[Nadal M., Eckerle K.L, Early E.A. and Ohno Y., “Final report on the key comparison CCPR-K5: Spectral diffuse reflectance”, Metrologia 50, 02003 \(2013\)](#)
- In the field of **gonioreflectometry** there is **no international comparison** dedicated to a set of standard geometries for bidirectional reflection
- Inter-laboratory comparison of the facilities in the wavelength range 380 nm to 780 nm, the $V(\lambda)$ -region of visual appearance
- From the results the measurement uncertainty budget for every instrument and systematic errors will be analyzed

xD-Reflect: Traceability of instruments

- Photos showing the different gonioreflectometer facilities:

Comparison in 0:45 or 45:0 geometry





xD-Reflect: Traceability of instruments

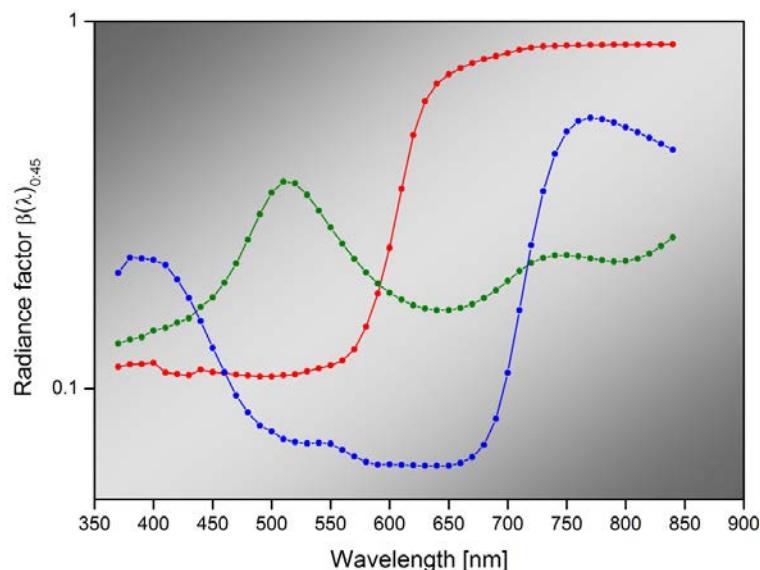
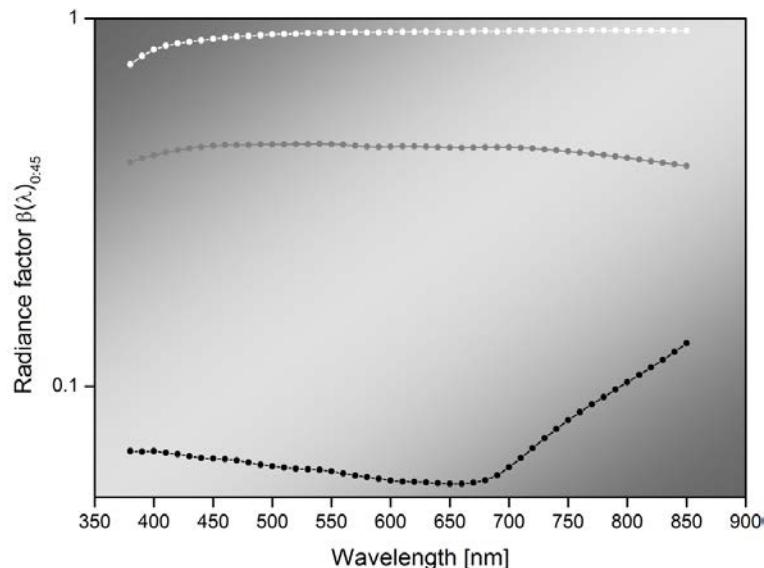
- A set of 3 grey-scale standards and 3 colored standards will be compared



- 88 % white, 40 % grey and 5 % deep grey

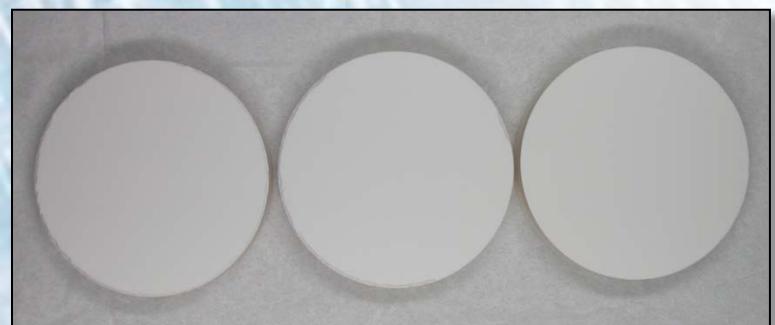


- red, green and deep blue

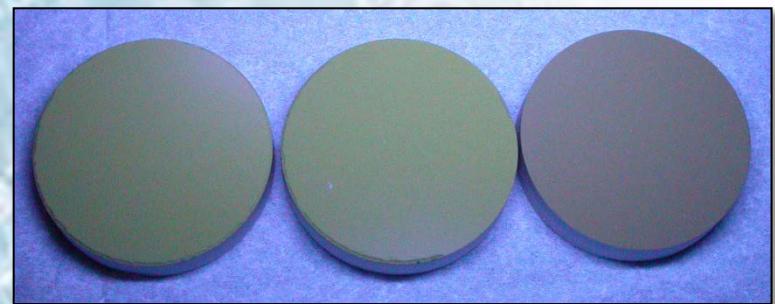




xD-Reflect: Traceability of instruments



- 88 %
white



- UV
254 nm

LUCIDEON
formerly
ceram



- UV
365 nm





xD-Reflect: Traceability of instruments

Sets of grey-scale standards and colored standards
in transport cases



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xD-Reflect: Definition of Sparkle/Graininess

Directional illumination



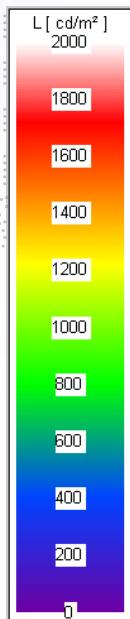
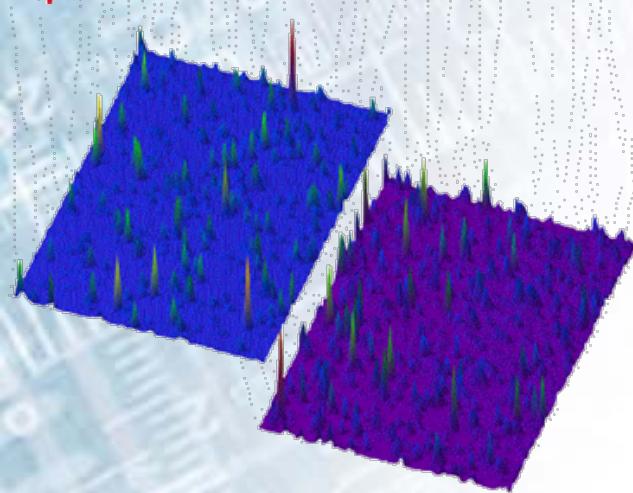
Diffuse illumination



Luminance camera



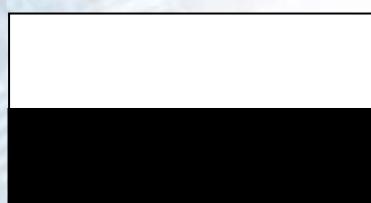
MERCK  xirallie Crystal Silver



- Spatially resolved measurement ($28 \mu\text{m}$)



xD-Reflect: Definition of Sparkle/Graininess



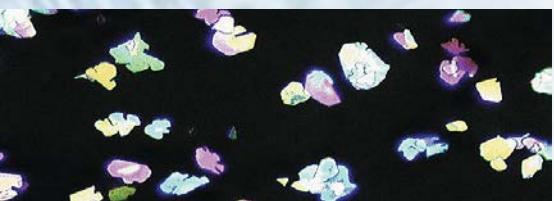
same concentration as ①
additionally carbon black

reduced concentration to ②
same carbon black as ①

xD-Reflect: Definition of Sparkle/Graininess

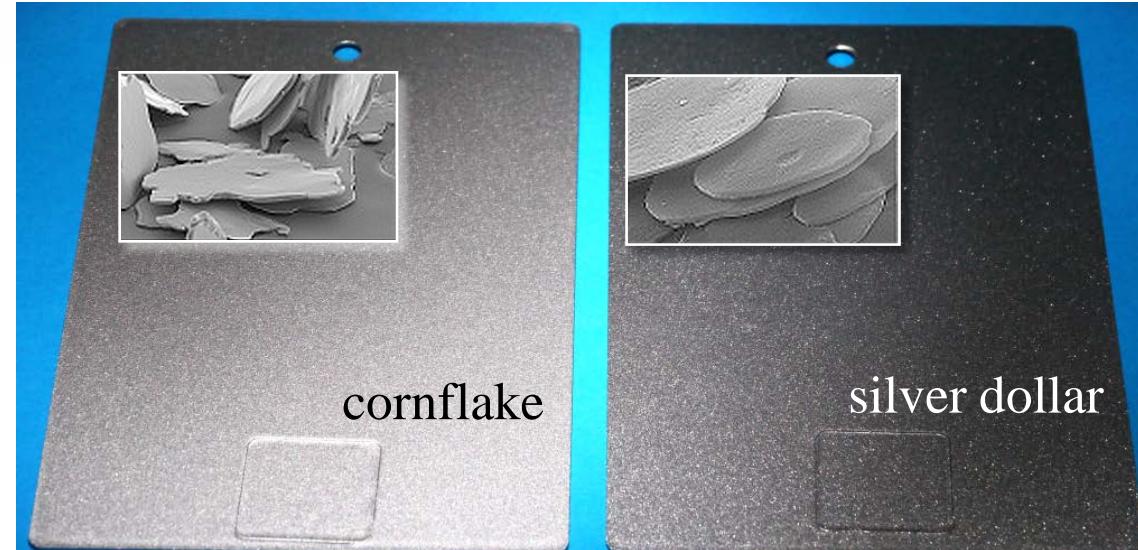
- First samples for the investigation of Sparkle

Xirallic® Crystal Silver



- Aluminium pigments in different configurations and particle sizes

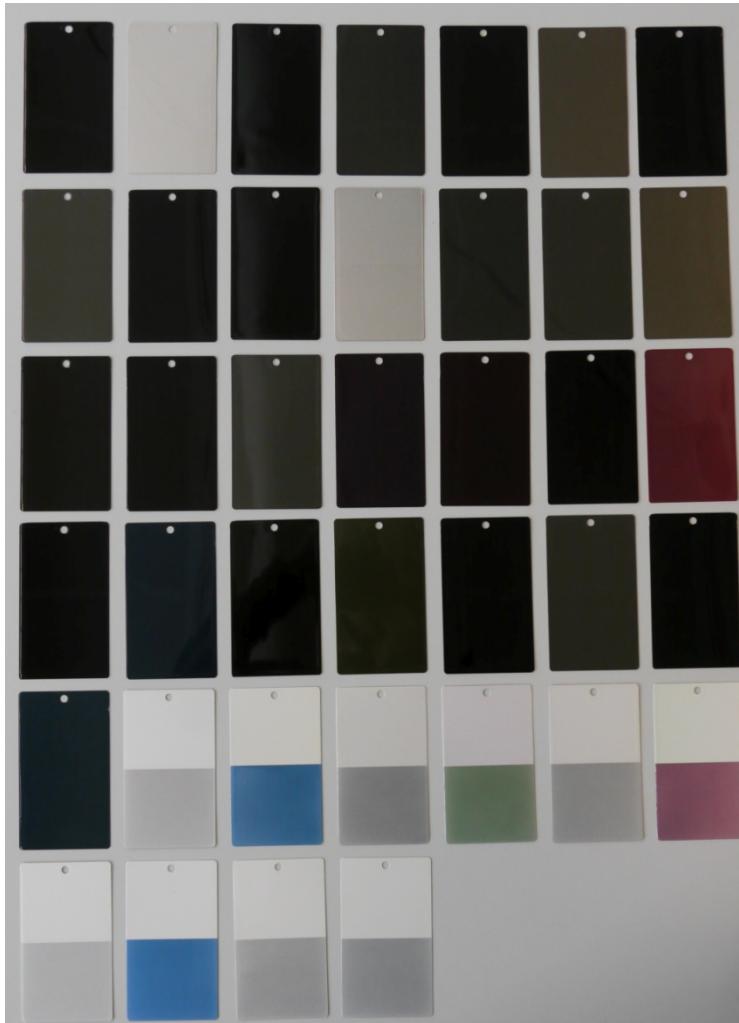
$\varnothing \approx 35 \mu\text{m}$ \Rightarrow





xD-Reflect: Effect characterisation

- 43 effect pigment samples:
- different pigments
- different concentrations
- different gradations
- different backgrounds
(black/white)





xD-Reflect: Summary & Outlook

- EMRP Project xD-Reflect started in September 2013, 3 years run-time
- Members: 7 European NMIs, 1 NMI external to the European Community, 3 Universities/Research Institutes
- Main areas of activity:
 - Goniochromatism
 - Gloss
 - Fluorescence
 - Modelling and Data Analysis
 - Visual Perception
- Selected objectives:
 - Proposal of new types of reference artifacts for calibration and characterisation of goniochromatism, gloss of and fluorescence
 - Reinforce the link with industry by creating a BRDF/BSDF public domain database for new advanced functional surfaces
 - Propose new standard recommendations for gloss measurements, that take into account the visual perception, the background and is adapted to modern surfaces



xDx
Reflect
Select



EMRP

European Metrology Research Programme

► Programme of EURAMET



The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union



Thank

Vielen Dank

Merci beaucoup

you

very

much

for

your

attention

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