24. – 27. June 2014
Espoo, Finland

xD-Reflect

"Multidimensional Reflectometry for Industry"

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

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xDReflect

Overview:

- The European EMRP Programme
- xD-Reflect in short,

  the different Work Packages
- WP1 “Goniochromatism“

EURAMET
European Association of National Metrology Institutes

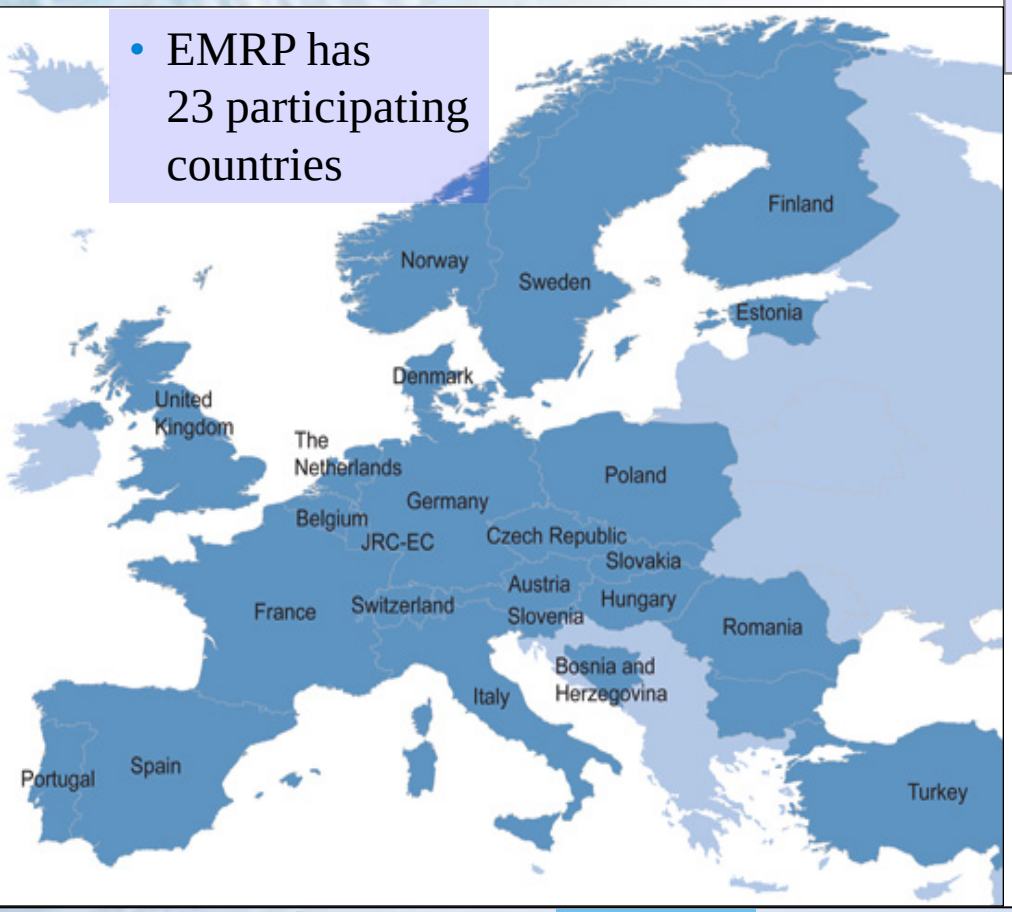
- The European Metrology Research Programme (EMRP) is jointly supported by the European Commission and the participating countries within the European Association of National Metrology Institutes (EURAMET).
- The EMRP enables European metrology institutes, industrial organizations and academia to collaborate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

European Commission

MSL Measurement Standards Laboratory of New Zealand
KU LEUVEN
CSIC Consejo Superior de Investigaciones Científicas
MIKES
SP
PTB
Universitat d'Alacant
Universidad de Alicante
le cnam
INRiM Istituto Nazionale di Ricerca Metrologica
INNVENTIA
CMI

EURAMET
European Association of National Metrology Institutes

- 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

MSL Measurement Standards Laboratory of New Zealand · KU LEUVEN · CSIC Consejo Superior de Investigaciones Científicas · MIKES · SP · PTB · Universitat d'Alacant Universidad de Alicante · le cnam · INRiM Istituto Nazionale di Ricerca Metrologica · INNVENTIA · CMI

xD-Reflect: Consortium members

Funded Partners:

- le cnam
- PTB
- MIKES
- CSIC – Consejo Superior de Investigaciones Científicas
- INRiM – Istituto Nazionale di Ricerca Metrologica
- CMI
- SP

REG´s:

- KU LEUVEN
- Universitat d'Alacant / Universidad de Alicante
- INNVENTIA

Unfunded Partner:

- MSL – Measurement Standards Laboratory of New Zealand

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

xD-Reflect: Web page

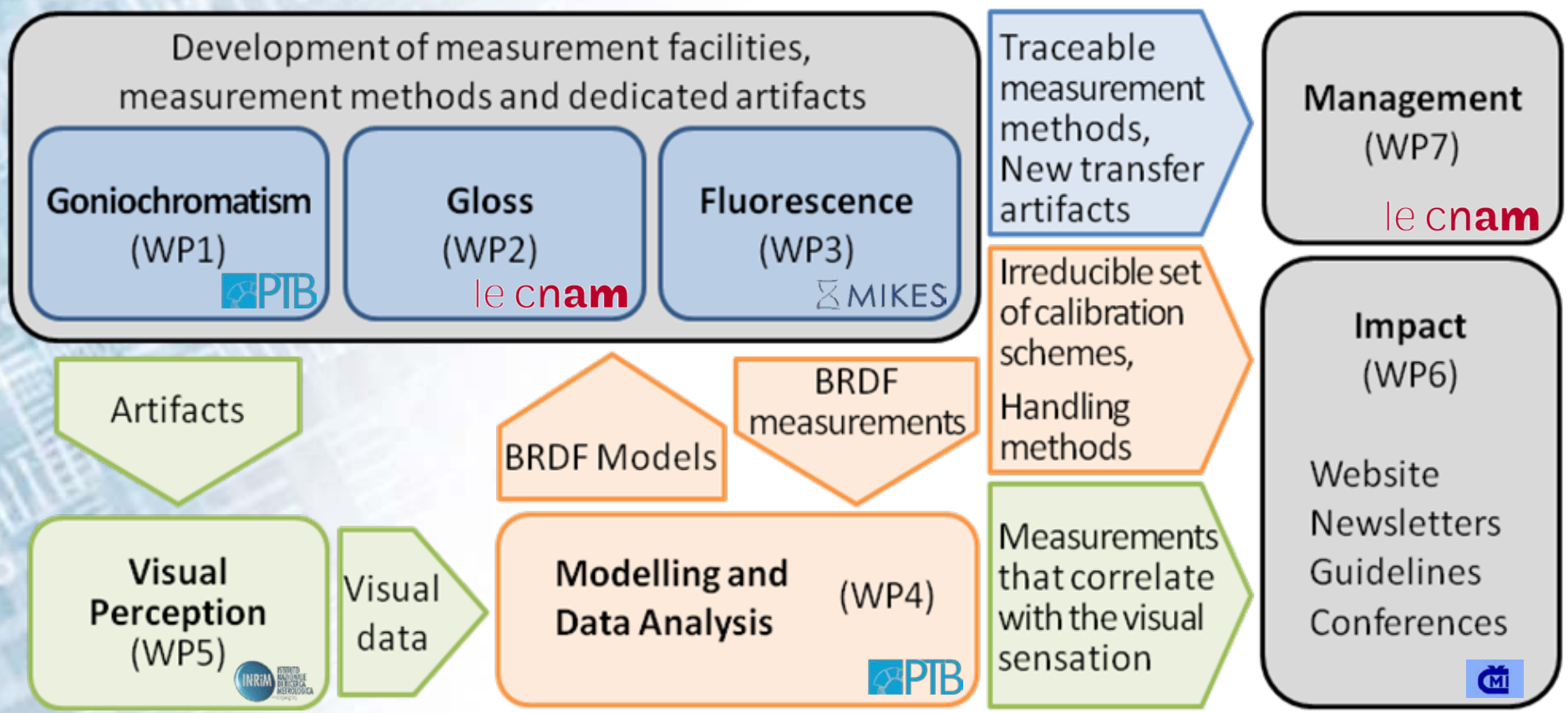
- Project start:

  September 2013

- Visit our web page at:

  www.xdreflect.eu

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

xD-Reflect: The work packages

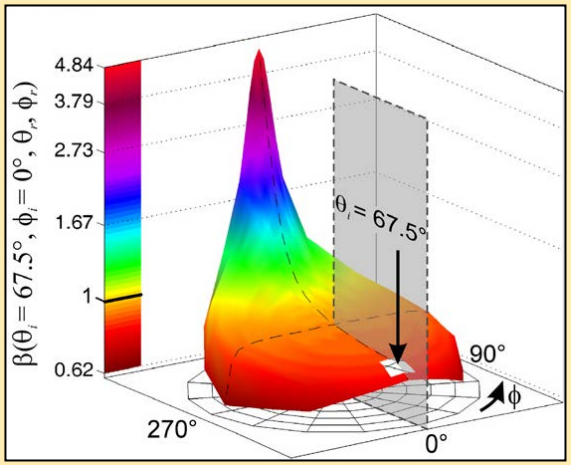
WP3: Fluorescence

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

MIKES

WP4: Modelling and Data Analysis

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

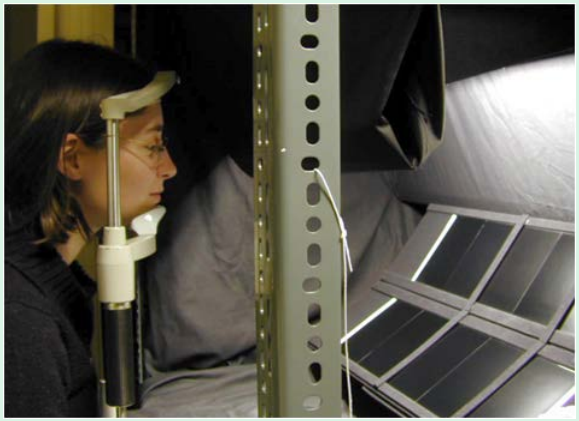


PTB

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

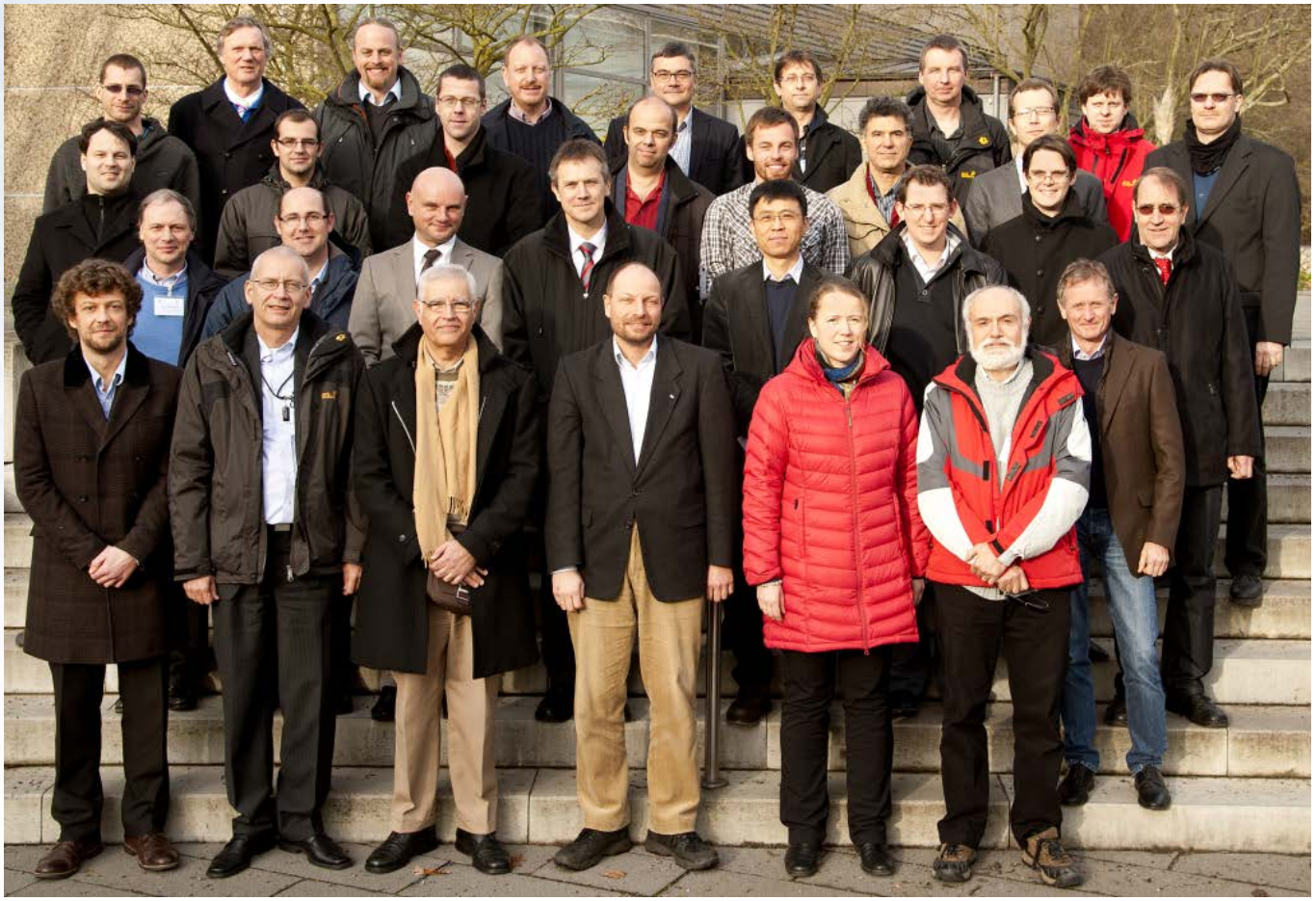
- The aim of this workpackage is to ensure that the results achieved by the project are adequately and appropriately communicated to the stakeholders and end-user community and that input and feedback is obtained from this community
- Web page, Newsletter, Conferences, Guidelines

xD-Reflect: Project meetings

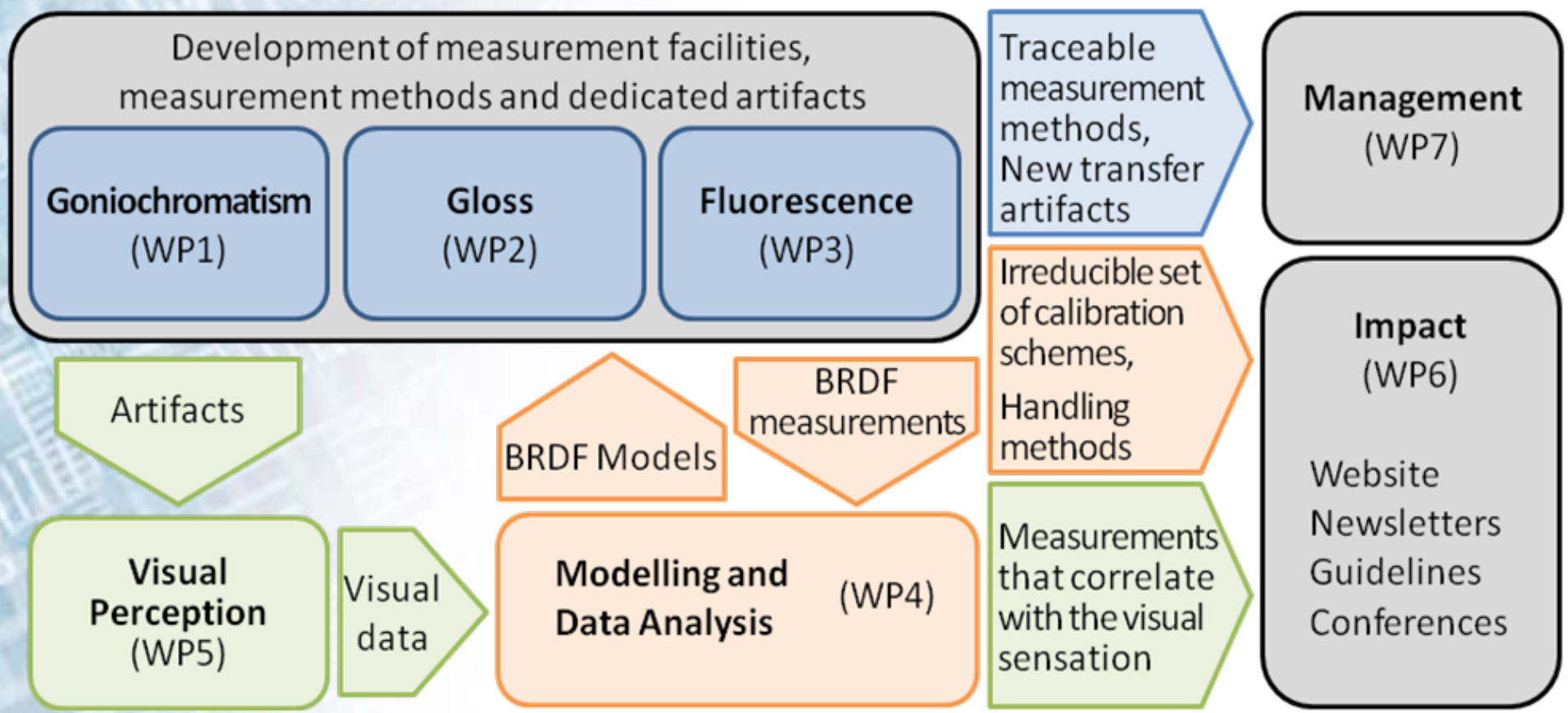
- Kick-off meeting with the whole scientific consortium Paris, September 2013

xD-Reflect: Project meetings

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



xD-Reflect: WP1 “Goniochromatism“



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

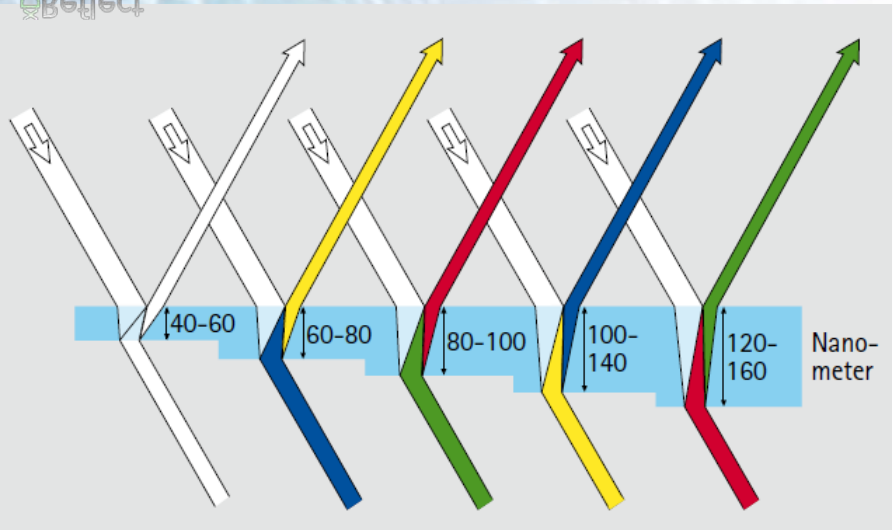
- Plastics and print industry

“Goniochromatism“, Effect pigments

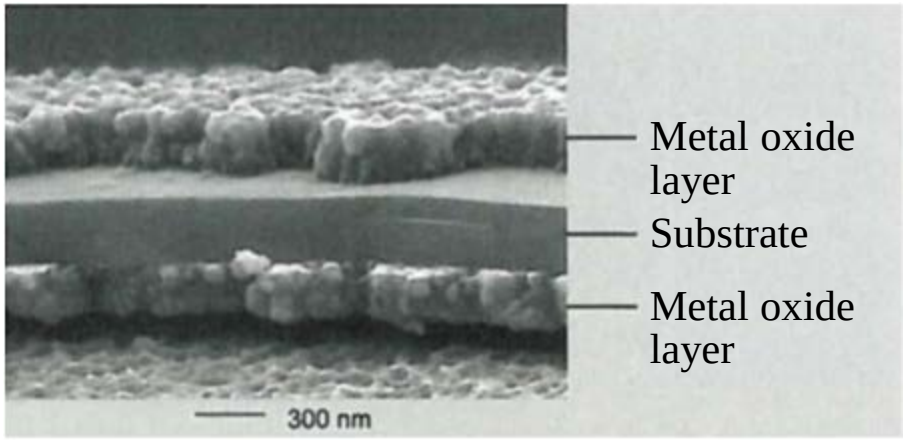
- Architecture
  Surface refinement

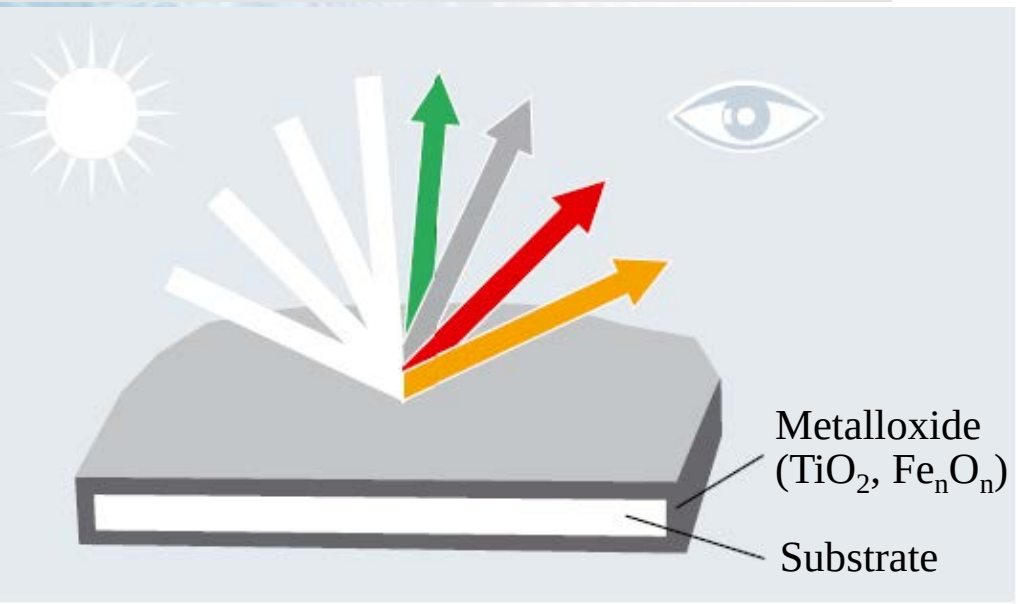
Office building, Braunschweig
Alucobond spectra colours

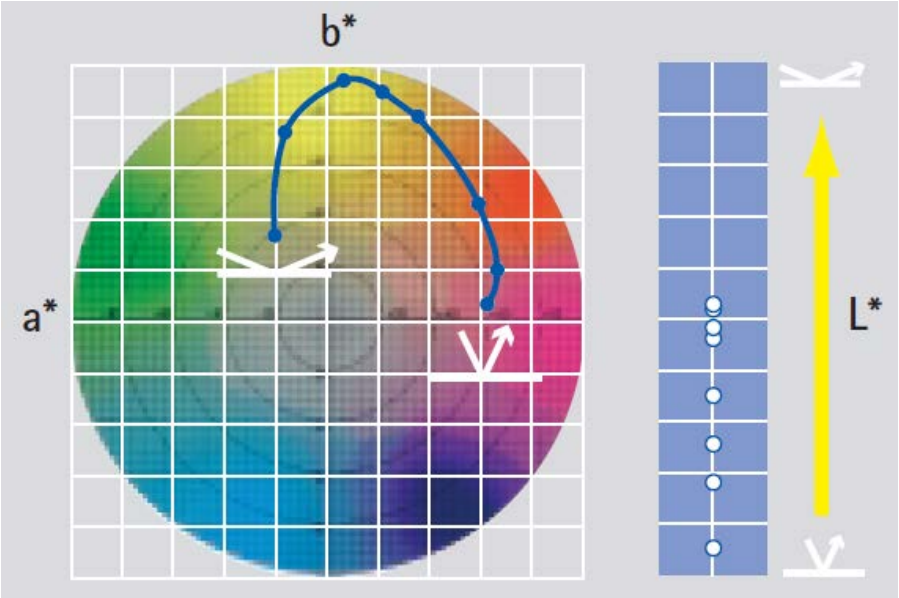
“Goniochromatism“, Effect pigments



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







xD-Reflect: Traceability of instruments

BIPM Bureau International des Poids et Mesures

KCDB

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

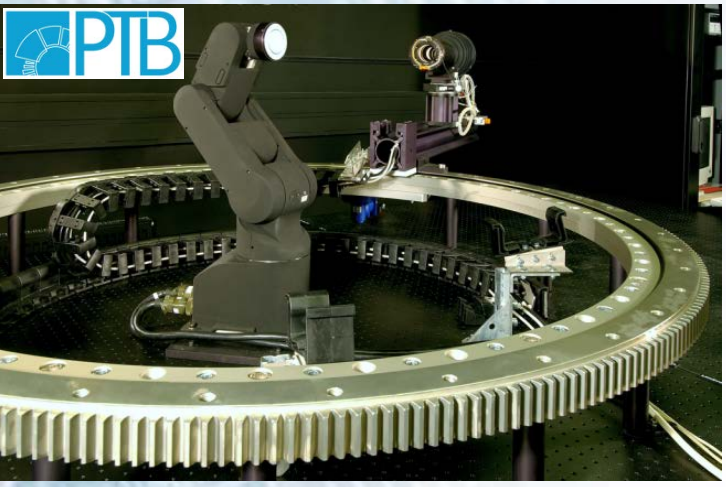
Improvement of the traceability for standard goniometric geometries

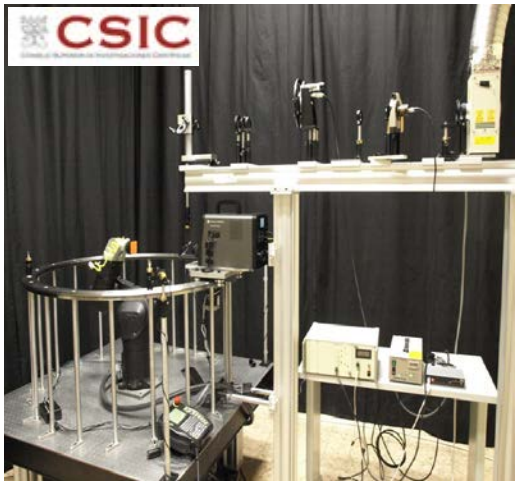
- In 2013 final results of CCPR-K5 “Spectral diffuse reflectance” (sphere geometries) were published,
  Nadal M., Eckerle K.L, Early E.A. and Ohno Y., “Final report on the key comparison CCPR-K5: Spectral diffuse reflectance”, Metrologia 50, 02003 (2013)
- In the field of gonioreflectometry there is 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(λ)-region of visual appearance
- From the results the measurement uncertainty budget for every instrument and systematic errors will be analyzed

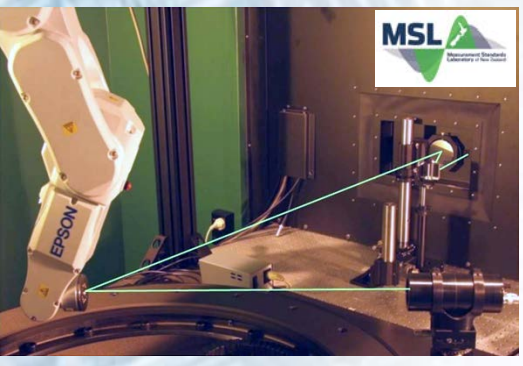
xD-Reflect: Traceability of instruments

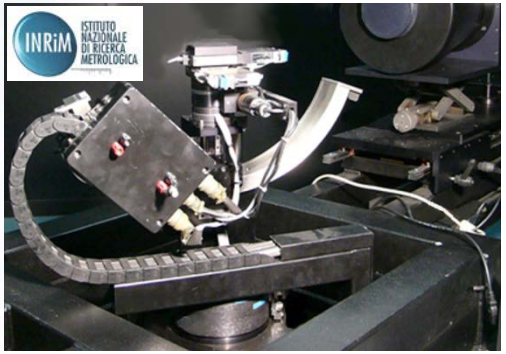
- Photos showing the different gonioreflectometer facilities:

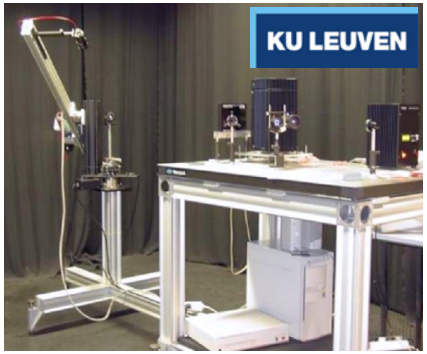
Comparison in 0:45 or 45:0 geometry

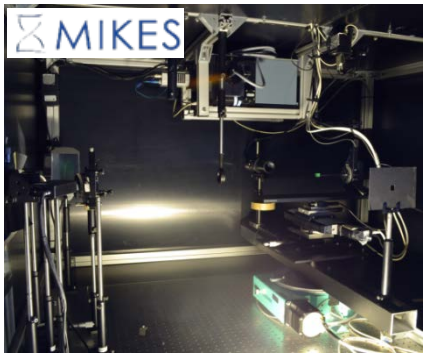










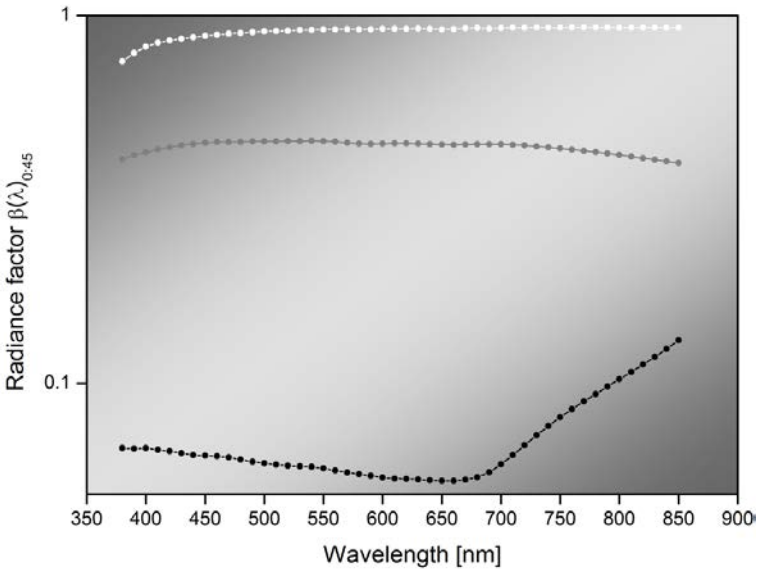


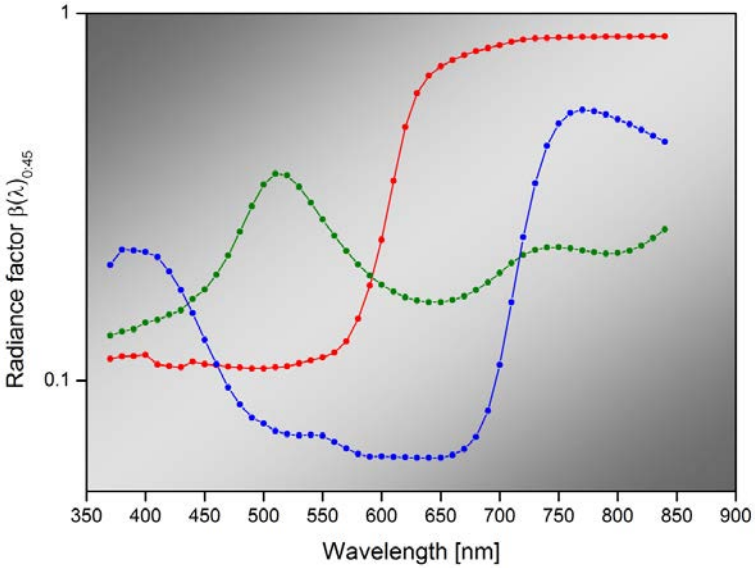
xD-Reflect: Traceability of instruments

- 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





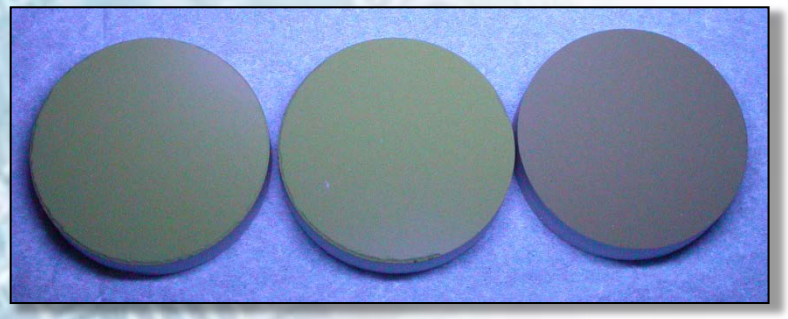
xD-Reflect: Traceability of instruments

- 88 % white

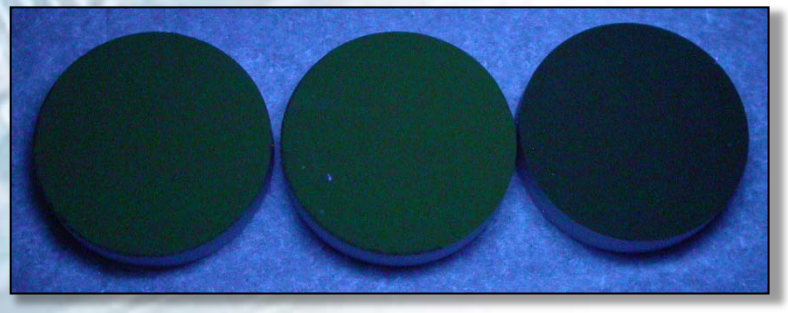
LUCIDEON

formerly

ceram



- UV 254 nm

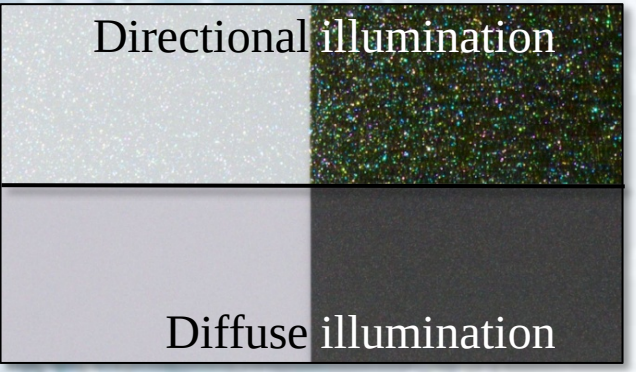


- UV 365 nm

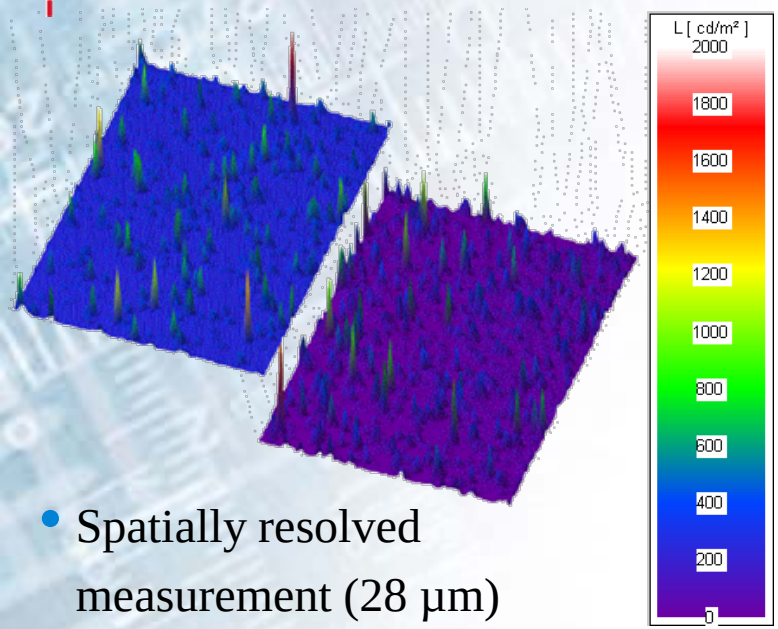
xD-Reflect: Traceability of instruments

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

xD-Reflect: Definition of Sparkle/Graininess



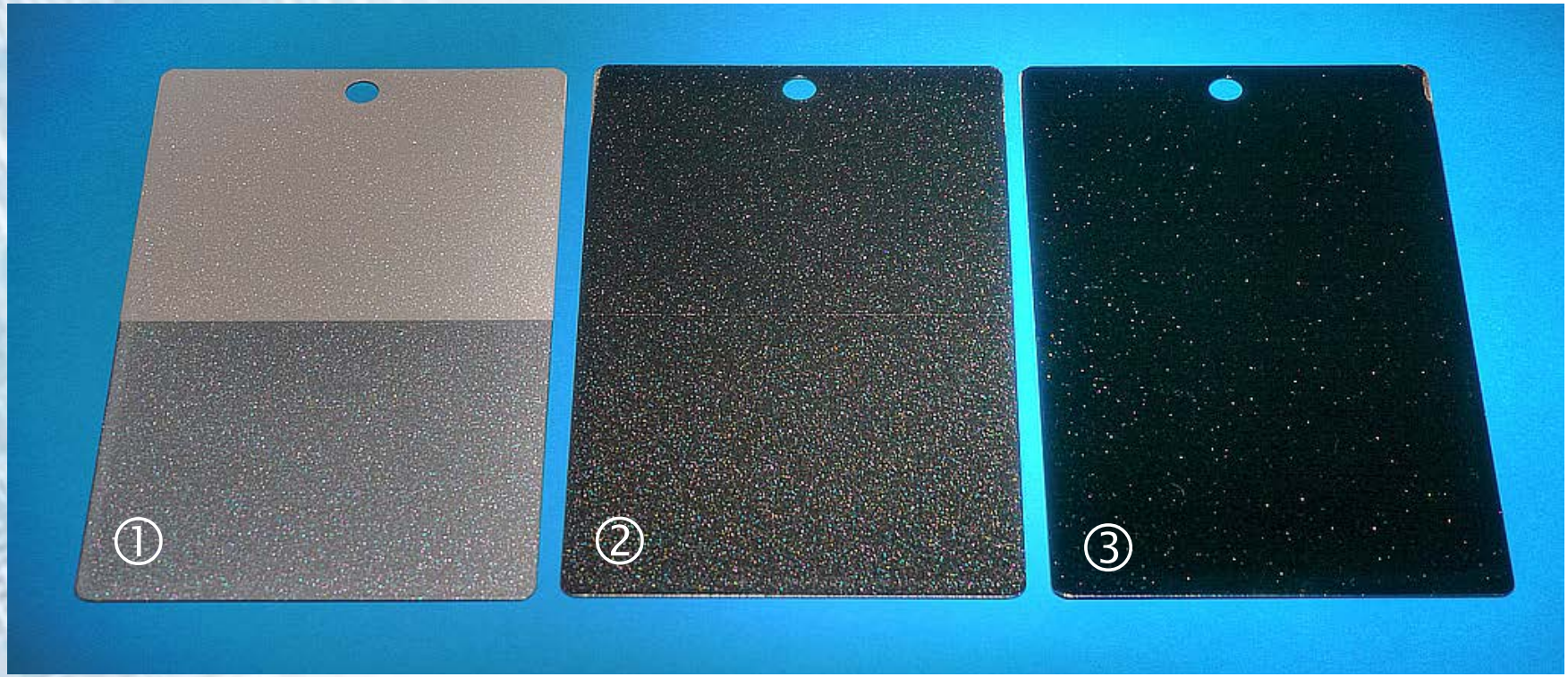
MERCK xirallic Crystal Silver



- Spatially resolved measurement (28 µm)

xD-Reflect: Definition of Sparkle/Graininess

MERCK xirallic Crystal Silver

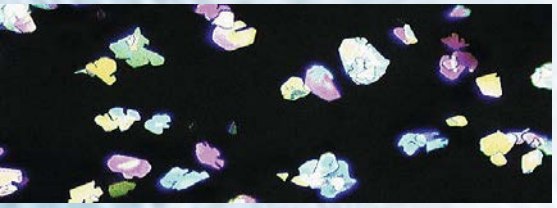


same concentration as ①
additionally carbon black

reduced concentration to ②
same carbon black as ①

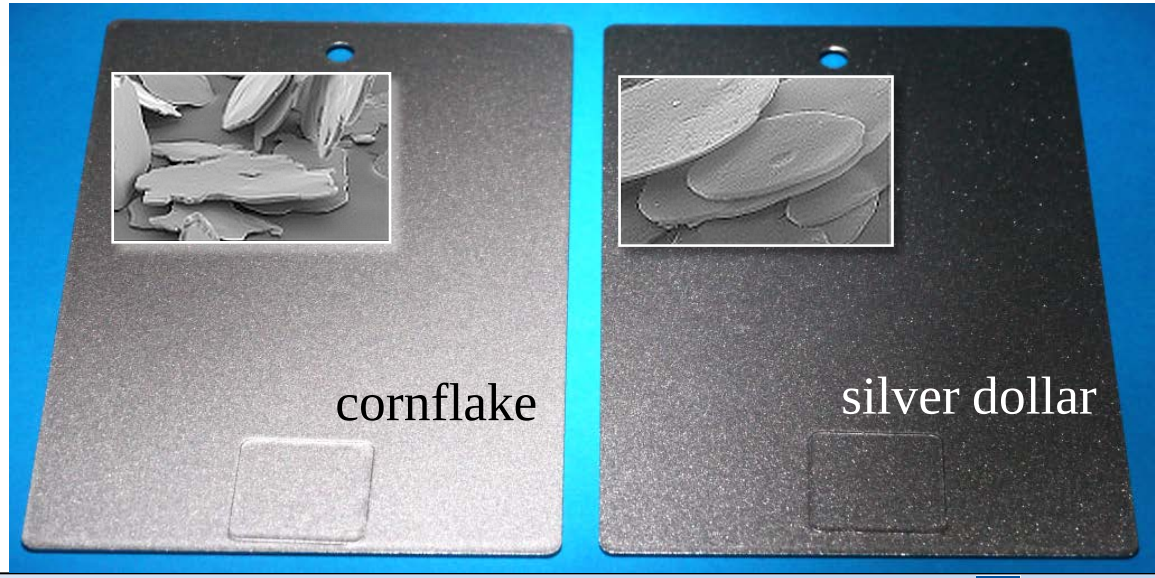
xD-Reflect: Definition of Sparkle/Graininess

- First samples for the investigation of Sparkle
  Xirallic® Crystal Silver MERCK



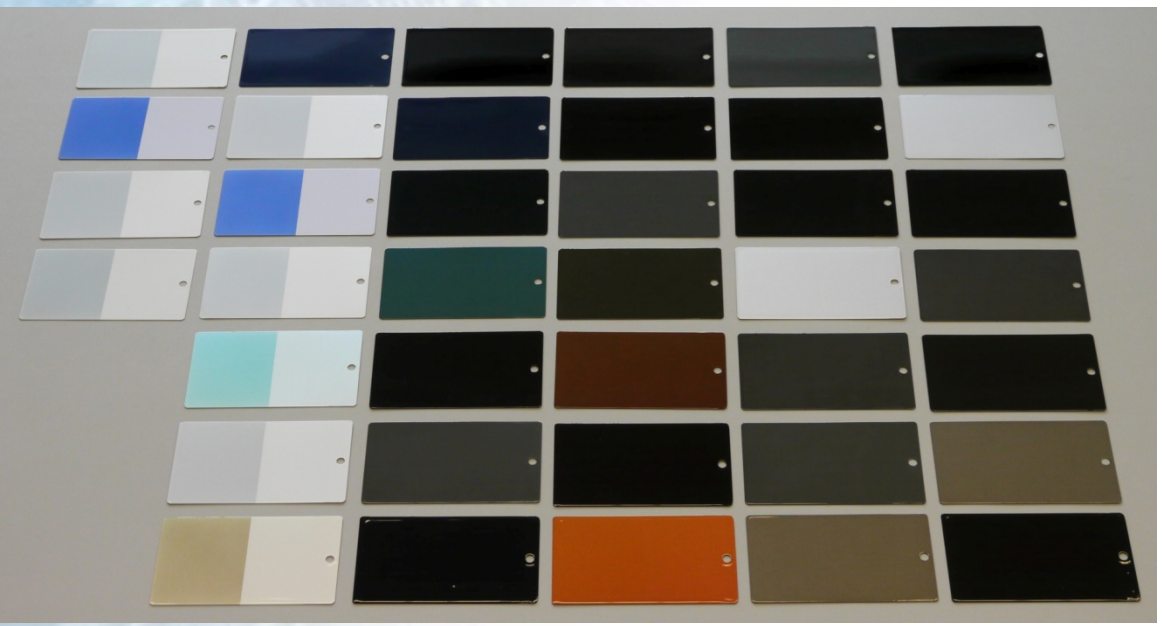
- Aluminium pigments in different configurations and particle sizes

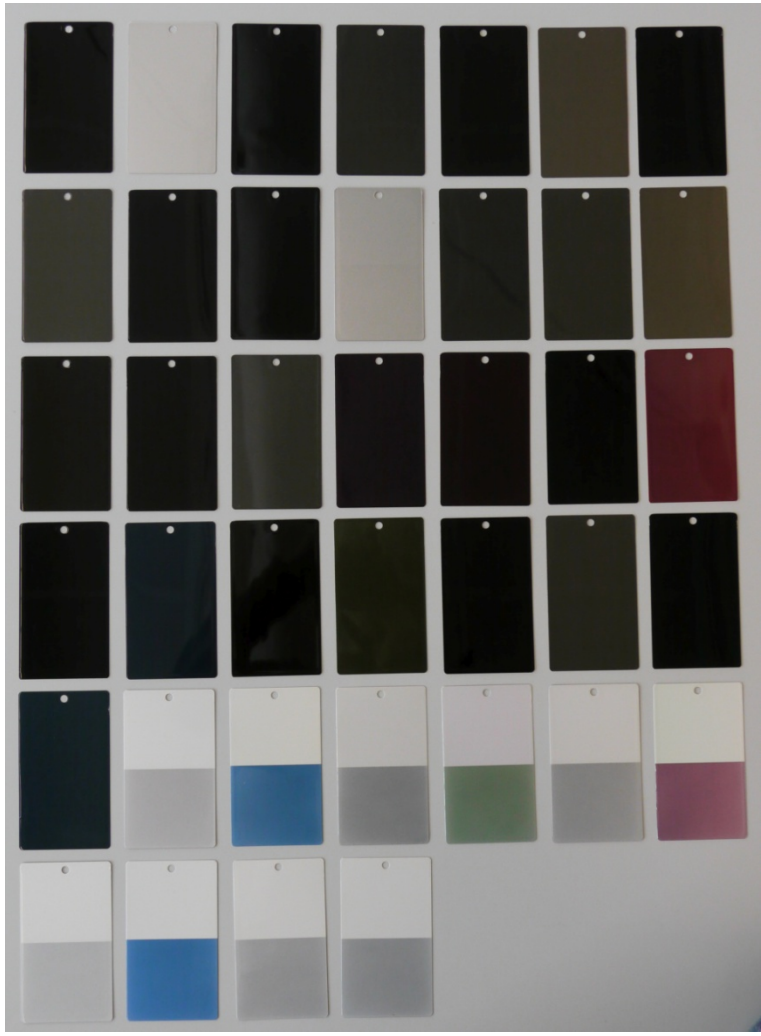
$\varnothing \approx 35\ \mu m$ ⟹



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

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Programme of EURAMET

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

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Thank you very much for your attention

Vielen Dank

Merci beaucoup

Tack så mycket

Muchas gracias

Paljon kiitoksia

Hartstikke bedankt

Mockrát děkuji

Mille grazie

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