WP 1: Goniochromatism

Characterization of new visual effects in the field of appearance of materials

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Outline

- Introduction
- Colour of effect pigments
- Appearance of effect coatings
- Challenges
- Outlook

Introduction

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Introduction

Terms of reference:

Identification of the main challenges to be addressed in the characterization of the appearance of the new visual effects introduced by effect pigments.

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Introduction

Any suggestion is welcome

Colour of effect pigments

- Metallic pigments.
- Interference pigments.
- Diffraction pigments.

Colour of effect pigments

Metallic pigments. They consist of a metal or an alloy of metal and their optical properties are described essentially by geometrical optics. They display a **metallic effect** which is mainly due to the directional reflection at the surface of the effect pigments.

Colour of effect pigments

Interference pigments. Two or more layers with a high index of refraction difference. Interference of the light waves, with additive color mixing. Hue, unlike metallic pigments, depends on the incidence angle on the pigment. Pearlescent pigments, which present the so-called **pearl effect**, are usually subsumed to this interference pigment classification.

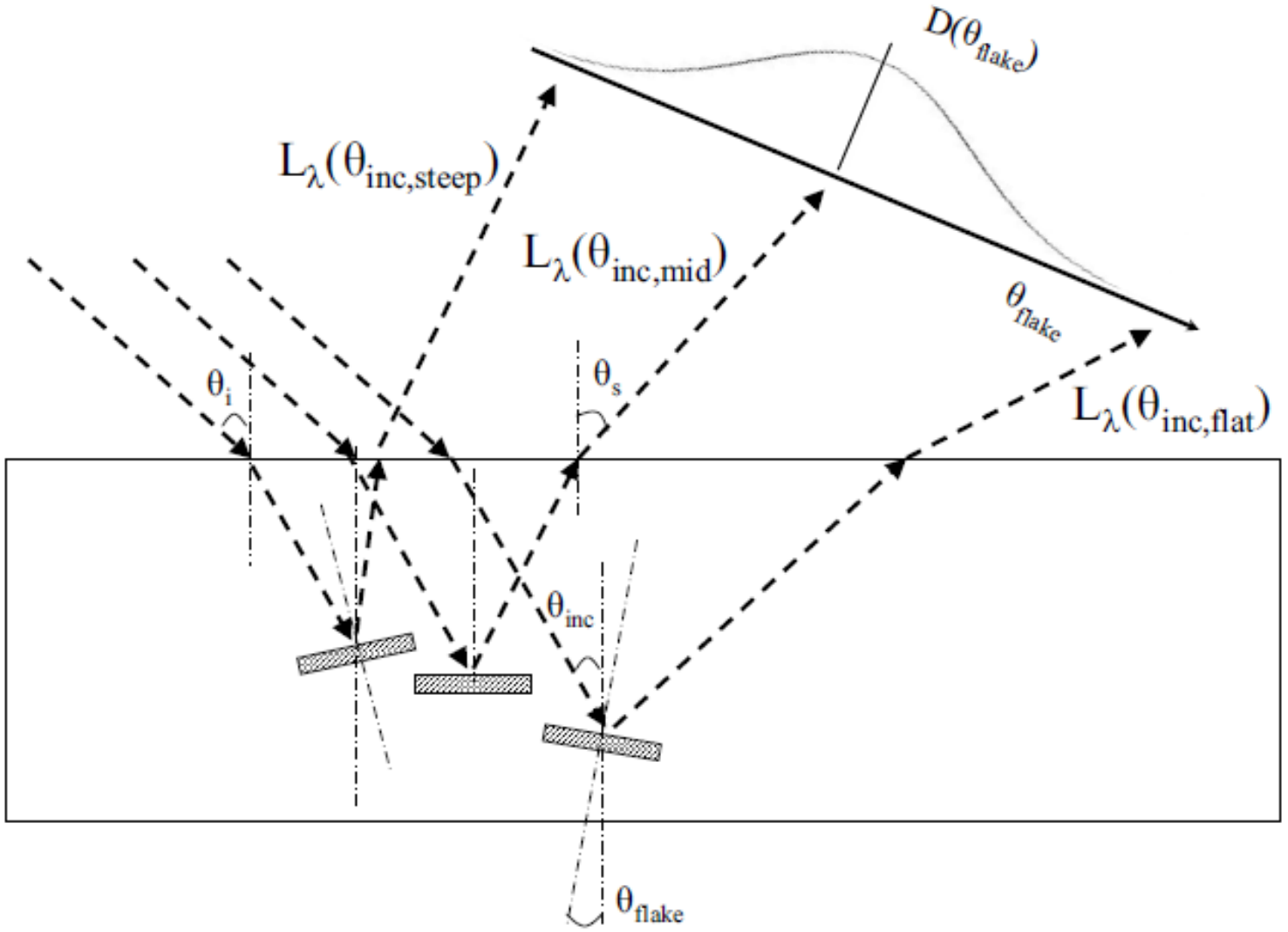
Colour of effect pigments

Diffraction pigments. They have a grating structure which deflects the incoming light. Like interference pigments, their optical properties are described by wave optics. Unlike metallic or interference pigments, their effect is not only observed around specular directions, but also at other directions. Since the deflection depends on the wavelength, the colour at a given observation direction depends on the deflection angle with respect to the flake normal.

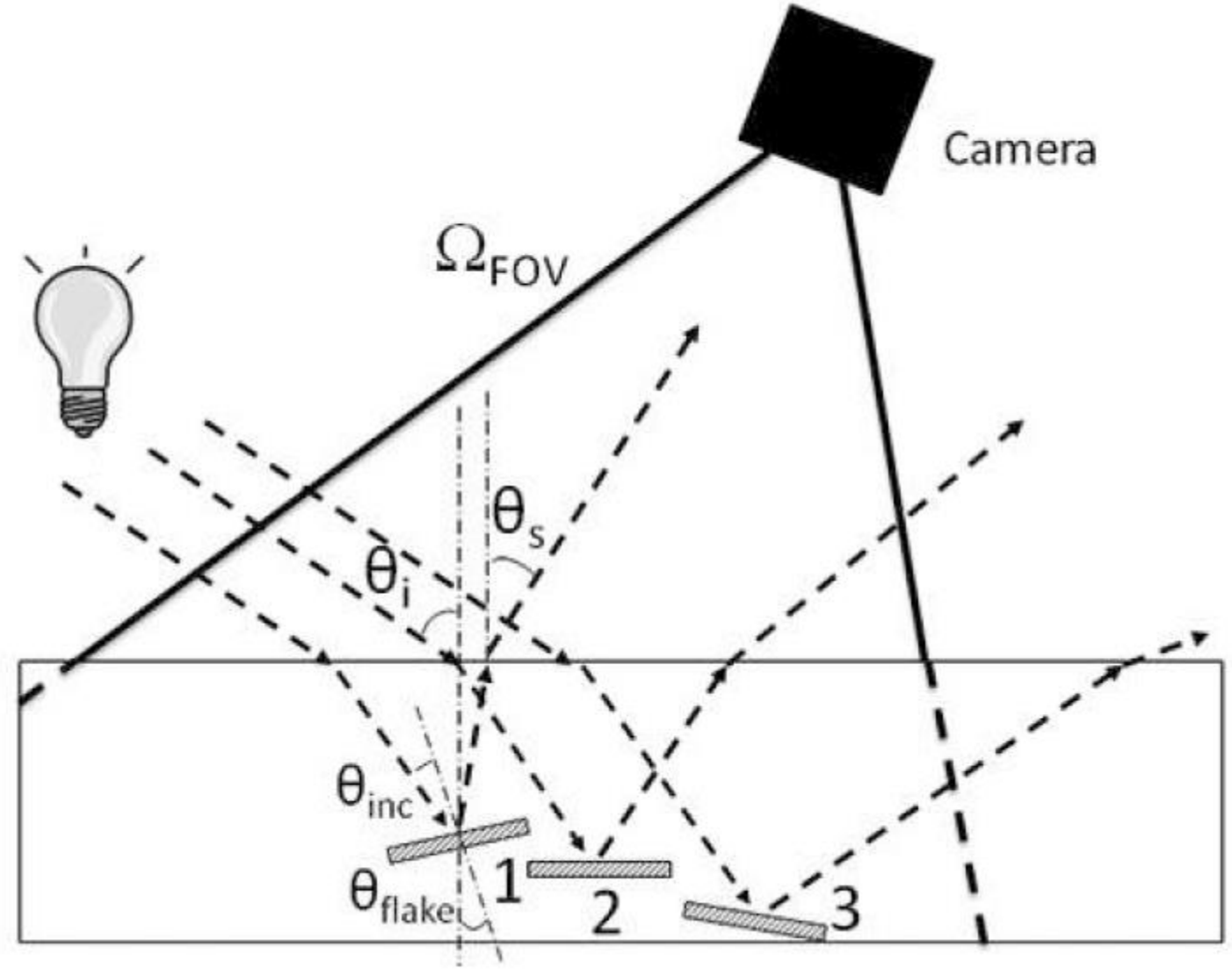
Appearance of effect coatings

- **Colour effect:** iridescence or goniochromatism.
- **Texture effect:** sparkle, glittering and graininess.

Appearance of effect coatings



Appearance of effect coatings



Appearance of effect coatings

Appearance of effect coatings

Challenges

Colour characterization

- In order to reach a thorough experimental knowledge of the colour of effect coatings, **goniospectrophotometers** for measuring the spectral BRDF at any illumination and collection directions **need to be available**.
- **Standarization for BRDF measurement** must be established, by recommending proper illumination and collection solid angles and measurement areas for specific kind of reflections (from angles close to specular angles to large aspecular angles).

Challenges

Colour characterization

- The most important **uncertainty sources** need to be identified.
- To provide a frame for the interpretation of the experimental data, **theoretical models** for the reflection of these effect coatings need to be worked out. These models are also required for interpolation of reflection data.

Challenges

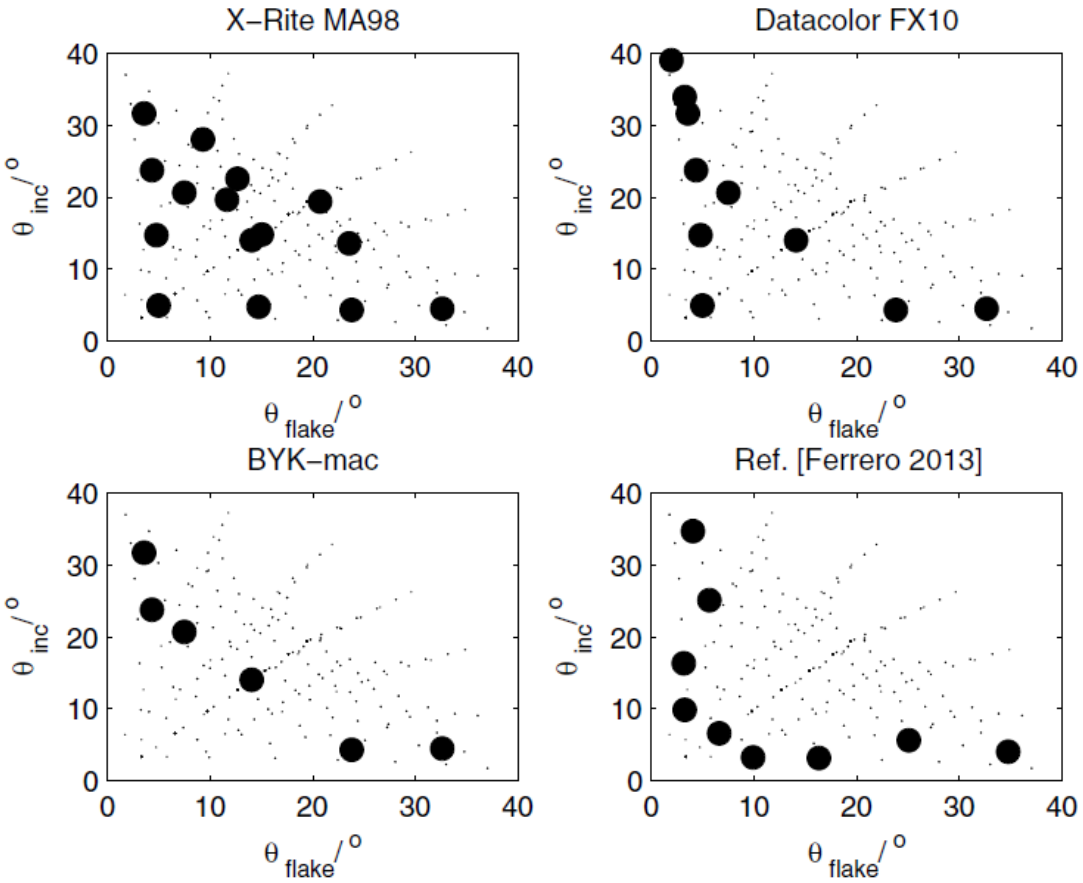
Colour characterization

- From empirical and theoretical considerations, **sets of basis geometries** to characterize the colour variation of the different types of effect coatings need to be selected.
- A set of basis geometries may be defined as a set of **independent and complete** pairs of illumination and collection directions.
  - **Independency** means that the estimation of the measure at any of those geometries cannot be derived from the measures at the others.
  - On the other hand, **completeness** means that an estimation of the measure at any other geometry can be derived from the measures at the geometries included in the basis set.

Challenges

Colour characterization:

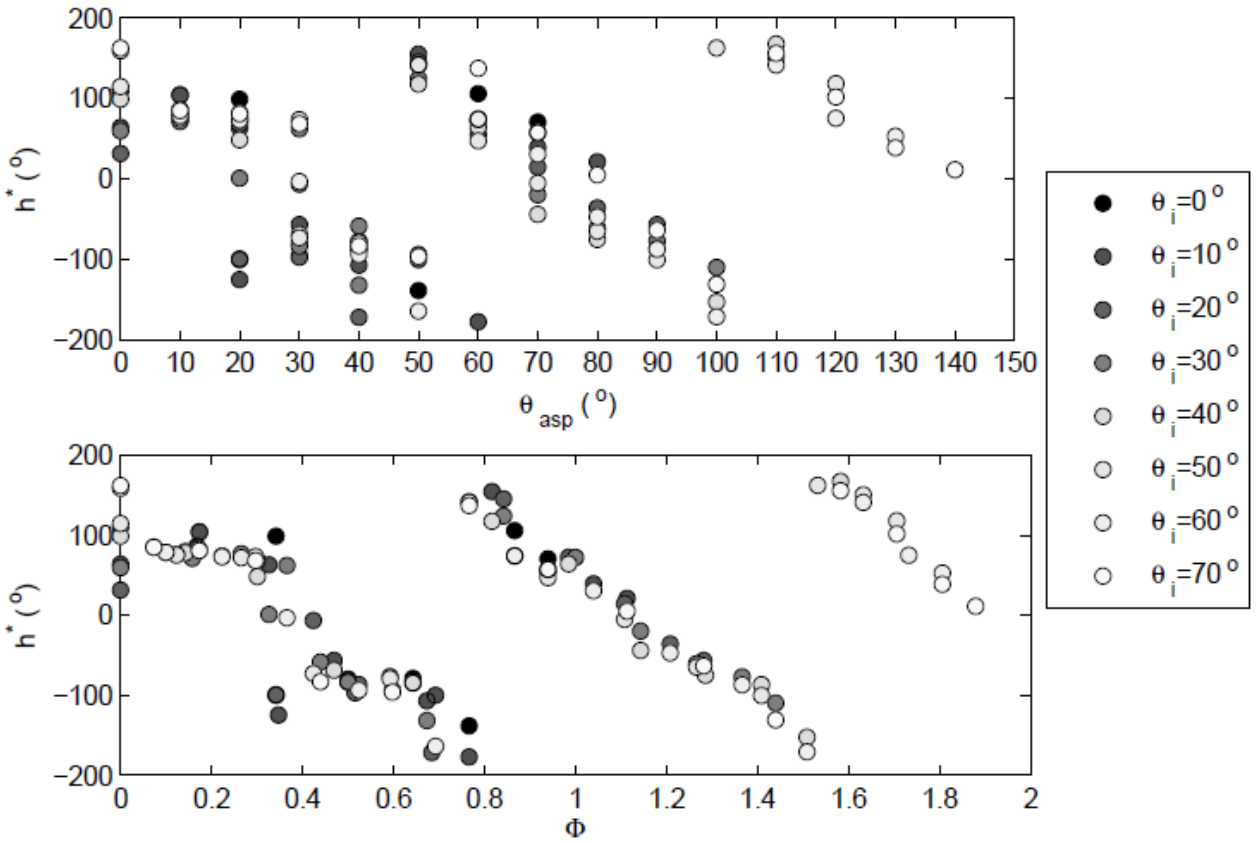
Interference pigments



Challenges

Colour characterization:

Diffraction pigments



Challenges

Colour characterization

- The selection of a basis set of geometries should be sufficient for:
  - **Requirements of industry**. Measurement at the basis set of geometries should allow descriptors used in industry for visual attributes to be calculated. Some of the descriptors usually adopted by industry are: Metallic gloss, brilliance, whiteness, lightness flop, hue extinction, or distinctiveness of image (DOI).
  - **Rendering**. As a consequence of the completeness, the spectral BRDF at any geometry can be obtained from the measurements by using a proper interpolation procedure.

Challenges

Colour characterization

- New **descriptors** for iridescence have to be defined, if it is required from the measurements .
- Psychophysical experiments must be carefully designed and carried out to develop a **measurement scale for iridescence**, based in the correlation between visual and spectrophotometric data.
- **Appearance difference formulas** must be defined, in order to quantify how different two effect coatings are and whether they can be considered indistinguishable or not.

Challenges

Texture characterization

- Since sparkle or glitter depends on the geometry, **near-field instruments that include image capturing** for measuring the texture at any illumination and collection directions **need to be available**.
- Based on the typical flake pigments sizes, **recommendations for selecting camera parameters** to measure texture need to be given. In principle, spectral response and spatial resolution on the object are the most relevant variables to be considered.

Challenges

Texture characterization

- **Theoretical models** for sparkle, glittering or graininess need to be worked out and tested.
- A procedure to measure **texture at any given geometry** needs to be established. Measurands need to be defined. Sparkle and glittering are visual effect described as a **distributed number of perceived bright point sources on a dark surround**. Therefore, measurands need to include somehow the description of the distribution of these point sources and the visibility of them.

Challenges

Texture characterization

- Since both sparkle and glittering are produced by effect pigments, they depend on the geometry. Then, similarly than in the case of colour, **sets of basis geometries** to characterize the variation of texture quantities need to be selected. Again, a set of basis geometries is defined as a set of **independent and complete** pairs of illumination and collection directions.

Challenges

Texture characterization

- **New descriptors** have to be defined to describe the appearance of sparkle, including its variation with the geometry.
- Psychophysical experiments must be carefully designed and carried out to develop a **measurement scale for sparkle or glittering**, based in the correlation between visual and spectrophotometric data.
- **Appearance difference formulas** must be defined, in order to quantify how different two effect coatings are and whether they can be considered indistinguishable or not.

Outlook

Previous considerations for the characterization of new visual effects may have impact in the recently created **CIE TC-85**, entitled **"Recommendation for BRDF measurements"**, specially those regarding the characterization of spectral BRDF of effect coatings. After the closure of this reportership, it will be proposed the creation of a TC for the characterization of sparkle.

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