BYK-mac i
Multi-angle color, effect and fluorescence measurement

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What is Fluorescence?

Fluorescence is the emission of light by a substance that has absorbed light or other electromagnetic radiation. It is a form of luminescence. In most cases, the emitted light has a longer wavelength, and therefore lower energy, than the absorbed radiation.

The mineral Fluorite (A) emits visible light when exposed to ultraviolet light (B).

What is Fluorescence?

Stokes Shift:
- The emitted energy is divided in heat and light
  ↓
- Fluorescent light has lower energy → long wavier than the excited light.

Typical Application:
- Paper with optical brighteners
- Textiles with optical brighteners
- Automotive colors?

Excitation		Emission
UV		Blue / Green / Yellow / Red
Blue		Green / Yellow / Red
Green		Yellow / Red
Color spectrophotometer with polychrome illumination

Light source
Xenon flash
Halogen lamp
Tungsten lamp

Object

Spectrometer

Microprozessor
Principle: Spectrophotometer with polychrome illumination

Fluorescent samples are always metamer!

- Amount of excited light is dependent on light source (Tungsten lamp – Xenon flash – LED)
- Amount of fluorescence will vary with lamp ageing
- Inter-instrument agreement often poor on fluorescent samples
BYK-mac with sequential monochrome illumination

Sample → Sensor → Spectral data

LED´s

Fluorescent Sample

Allocation of emitted fluorescent light to excitation wavelength
## Polychrome Illumination vs Monochrome illumination

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<th>Traditional technique</th>
<th>BYK-mac</th>
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<tr>
<td>• Polychrome illumination</td>
<td>• Monochrome illumination</td>
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<td>• Continuous spectrum</td>
<td>• 26 single LEDs</td>
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<td>• Light dispersion on detector side</td>
<td>• Light dispersion on the illumination side</td>
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<td>• Detector: Spectrometer or Filters</td>
<td>• Detector: Photodiode integrating signal</td>
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<tr>
<td>• Amount of excited light dependent on type/age of light source</td>
<td>• Amount of excited light constant due to LED stability</td>
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<tr>
<td>• Allocation of emitted fluorescence light to emission wavelengths</td>
<td>• Allocation of emitted fluorescence light to excitation wavelength</td>
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Example RAL 3020-GL Traffic Red

Absolute Comparison

BYK-mac: Fluorescence light is allocated to excitation wavelength
Fluorescence in Automotive Colors?
Fluorimeter setup

Photos: [www.byk.com](http://www.byk.com) - [www.lot-oriel.com](http://www.lot-oriel.com) - [www.tec5.com](http://www.tec5.com)
Results of the pigment investigation

Organic pigments applied in automotive and industrial paints

- P.Y. 139: Yellow
- P.Y. 185: Yellow (not common in automotive OEM)
- P.R. 178: Red
- P.R. 179: Red
- P.R. 282: Red (not common in automotive OEM)
- P.O. 73: Orange
- P.V. 19: Violet (gamma modification)

→ **Fluorescent light might appear when using these pigment types.**

→ The fluorescence effect is influenced by the production process and the interaction of the components.

→ Only small amount of automotive colors affected
Results of pigment investigation

Example: P.Y. 139: Yellow
Results of the pigment investigation

Example P.V. 19: Violett – gamma modification
Results of pigment investigation

Example: P.R. 179: Red

PR 179 drawdown: Masstone

Automotive Red Color
BYK-mac i: New technology

4 fluorescence detectors

• Measuring fluorescence light at shifted wavelength

• Allocation of fluorescent light to emission wavelength

• Quantification of fluorescence excited in the visible range
Comparison to conventional spectrophotometer

Absolute color comparison – Fluorescent Color

BYK-mac i: Fluorescence light is allocated to emission range
Measurement & Quantification of Fluorescence

Equation:

\[ \text{Int}_{\text{Emission}} = 10^4 \frac{\int FLLight \, d\lambda}{\int PWD \, d\lambda} \]

\( PWD \): Perfect White Diffuser

Graph showing the fluorescence light spectrum with wavelength on the x-axis and reflectance on the y-axis. The graph indicates a peak in fluorescence around 620 nm. The text also mentions the emission integral equation with an example value for RAL 3020 with \( \text{Int}_{\text{Emission}} = 7\% \).
Fluorescent Color RAL 3020: UV light exposure

Int\textsubscript{Emission} value high

Indication of poor light fastness

Original part (Reference)

UV exposed part (less fluorescent)
New BYK-mac i

- Excellent repeatability and inter-instrument agreement on all colors

- Excellent correlation to visual perception:
  - Light-Dark Flop as well as Color Flop
  - Sparkle and Graininess
  - Quantification of Fluorescence with new parameter $\text{Int}_{\text{Emission}}$

- Color display for ease of use at production line

- Smart-chart for process control and lab analysis with online mode
New BYK-mac i: Introduction

Launch of new BYK-mac i

Upgrade BYK-mac to BYK-mac i

September 2013
Thank you for your attention.