Spectroscopic investigation of synthetic pigments by time resolved Laser Induced Fluorescence (LIF) and X-ray Fluorescence (XRF) analysis.

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Outline

- Motivation
- Instruments and methods
- Reference (lab) samples
  - Green Phtalocyanine
  - Acrylic Binders
- Commercial samples
  - PG7 Polycolor
  - PB15 Polycolor
- Conclusions

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Motivation

- Characterization of Contemporary artwork materials
- Construction of a database of contemporary materials
- Planning for a proper conservation plan

- Identification of pigments and binders, often consisting of multi-component mixtures with unknown composition
- Advanced diagnostics obtained by a set of complementary non-destructive techniques

Luigi Boillè, Pittura, 1965, Collezione MACRO, Roma

Motivation

Pigments and Dyes:

- Phtalocyanines *(1920)*
- Azo Compounds *(1858)*
- Dioxazines *(1950)*
- Fluorescent Pigments *(1970)*
- White Pigments *(1900)*

Binders:

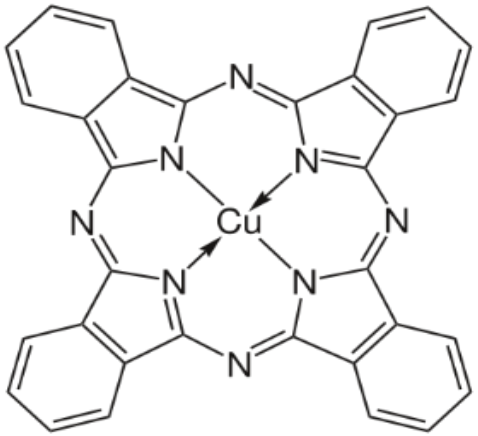
- Acrylic
- Vinyl
- Alkyd resins

(Since 1930)

Motivation

- Phtalocyanines (Pcs)
- The most important chromophoric system of the XX century
- Intensely blue-green-coloured aromatic macrocyclic compound

Nato Frascà, Nascita della Forma, 1962, Collezione MACRO, Roma



Permanent Blue (PB15)

- Excellent color strength, durability, and high stability
- Provides the most important blue and green pigments in the XX century artists' paints

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Instruments and methods: XRF and LIF

X ray Fluorescence (XRF)

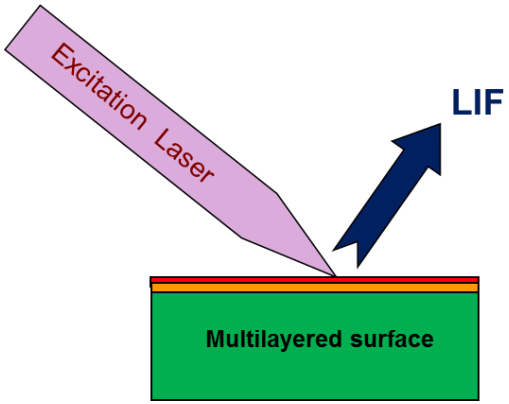
Field of analysis: 1-40 KeV,
Na (Z=11) to U (Z=92).
X ray collimation: down to 0.5 mm

Measurement Time: 60 s
Tube Voltage: 40 kV; 20 kV
Tube Current: 80 μA; 160 μA
Tube Target Material: Rh

Laser Induced Fluorescence (LIF)

Laser Induced Fluorescence is generated after the absorption of UV radiation

Compositional Analysis
Non Destructive Analysis
In Situ Technique (Led-IF)
Prompt Response



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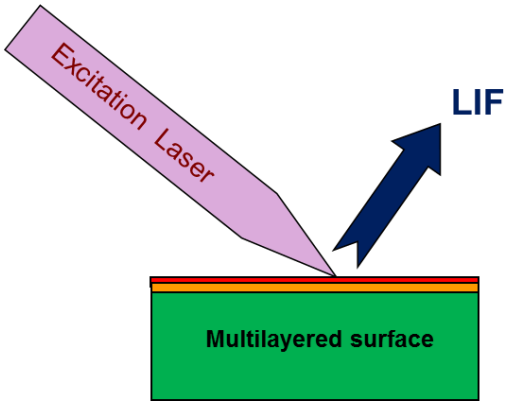
Prompt Response

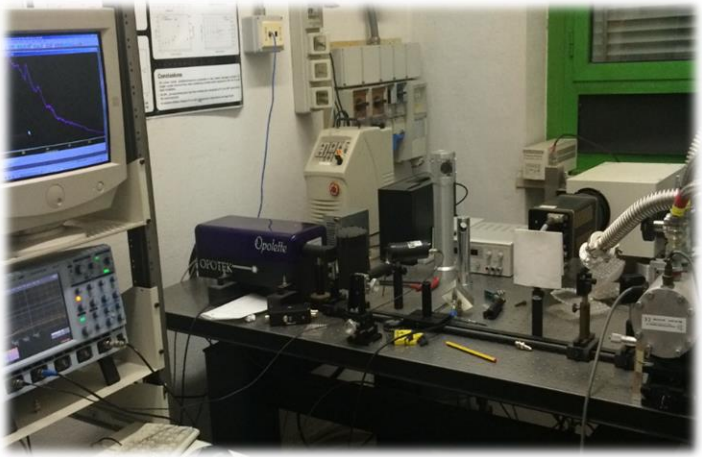
Time resolved detection can be performed



Instruments and methods: TR-LIF

TRL spectra were recorded in order to possibly discriminate between spectral contributions from different compounds contained in the paints

The analysis was performed by using a 210-2400 nm tunable laser (Opolette by Opotek), assembled with a 300 mm spectrograph (Acton Research 300i), and equipped with a gated multichannel plate CCD camera (PI-MAX by Princeton Instrument)



- The emission spectra were acquired by using **220 nm** as excitation wavelength
- A time scan analysis was acquired with a gate window of 3 ns and a delay step of 3 ns between consecutive recorded spectra

Investigated samples

PG7 Phtalocyanine, PB15 Phtalocyanine , Acrylic binder

Sample	Description
PB15 powder	Powder of the blue Phtalocyanines (PB15) pressed onto aluminum holder
PB15 Polycolor	Acrylic paint of the blue Phtalocyanines (PB15) and Titanium White (PW6)
PB15 +Acrylic Binder	Powder of blue the Phtalocyanines (PB15) mixed with the Acrylic Binder
PG7 Polycolor	Acrylic paint of the green Phtalocyanines (PG7) and Titanium White (PW6)
PG7 powder	Powder of the green Phtalocyanines (PG7) pressed onto aluminum holder
PG7 + Acrylic Binder	Powder of the green Phtalocyanines (PG7) mixed with the Acrylic Binder
Acrylic Binder	Acrylic Binder (PRIMAL B-60)

The Pcs used for this work are based on common and commercially available pigments from different manufacturers

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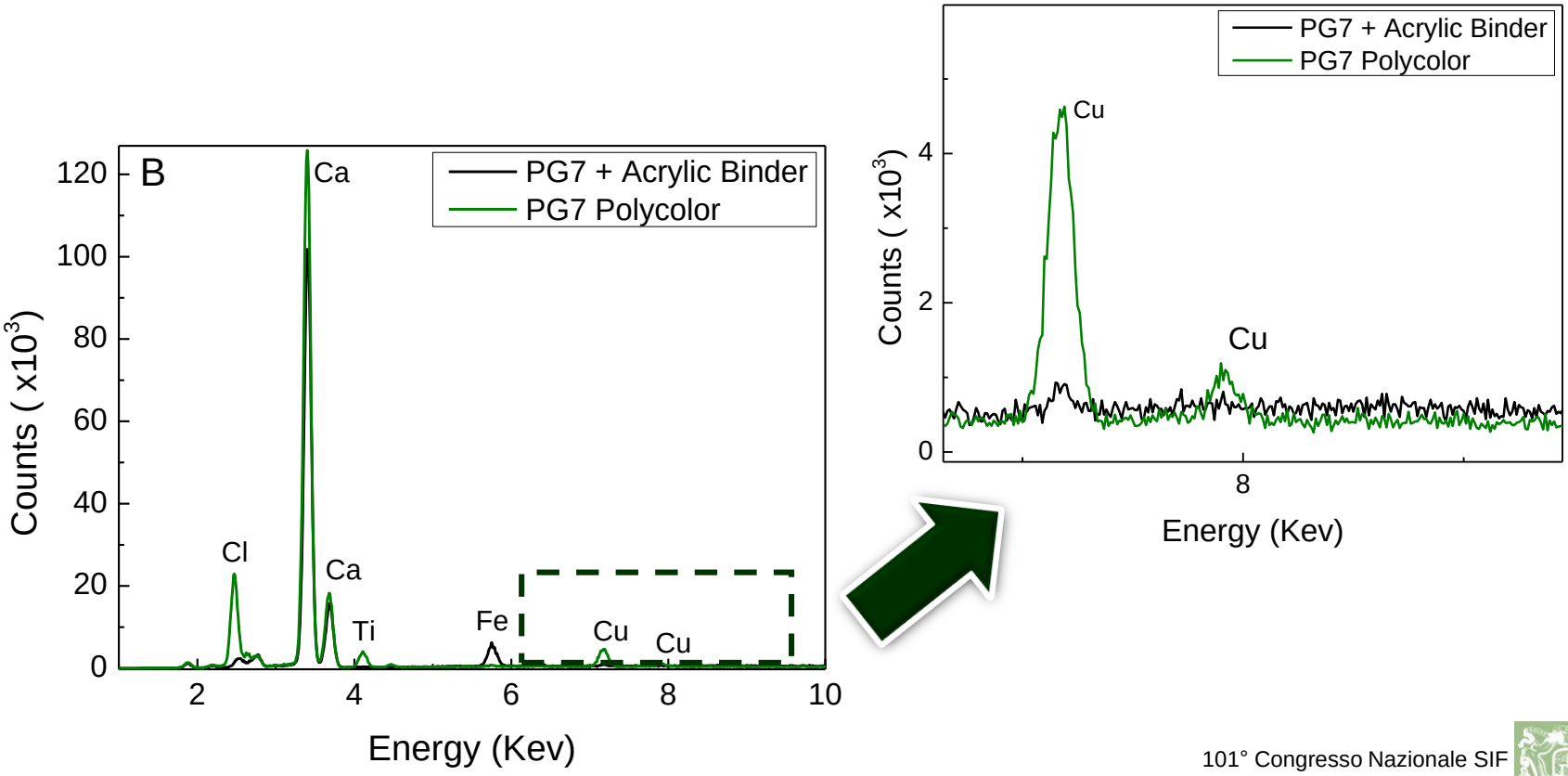
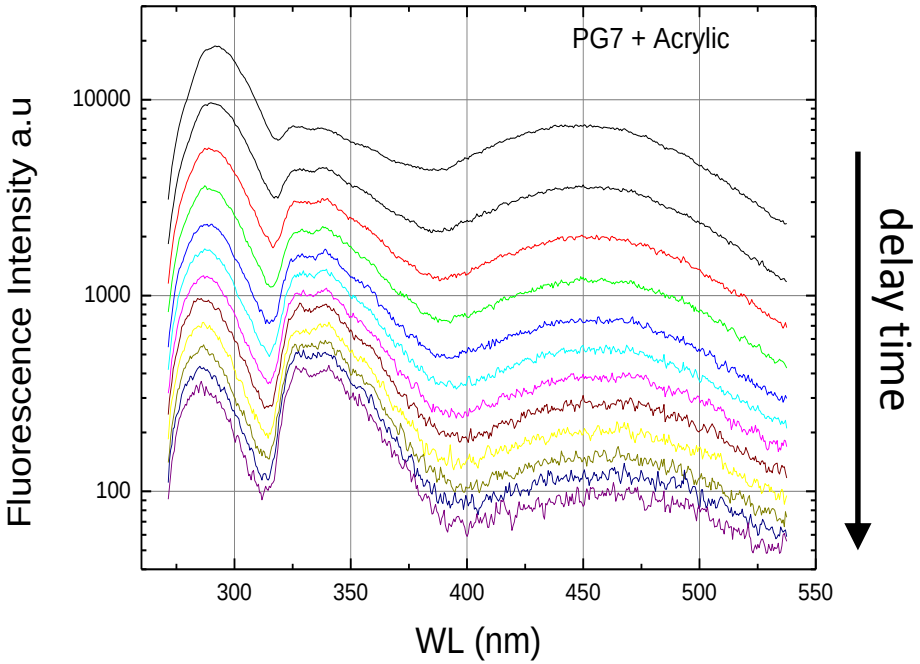
Investigated samples: XRF Analysis

- XRF analysis was performed in order to verify the chemical composition of the investigated samples
- Complementary diagnostic techniques are necessary to obtain an affordable compositional characterization



Reference (lab) samples: PG7 + Acrylic



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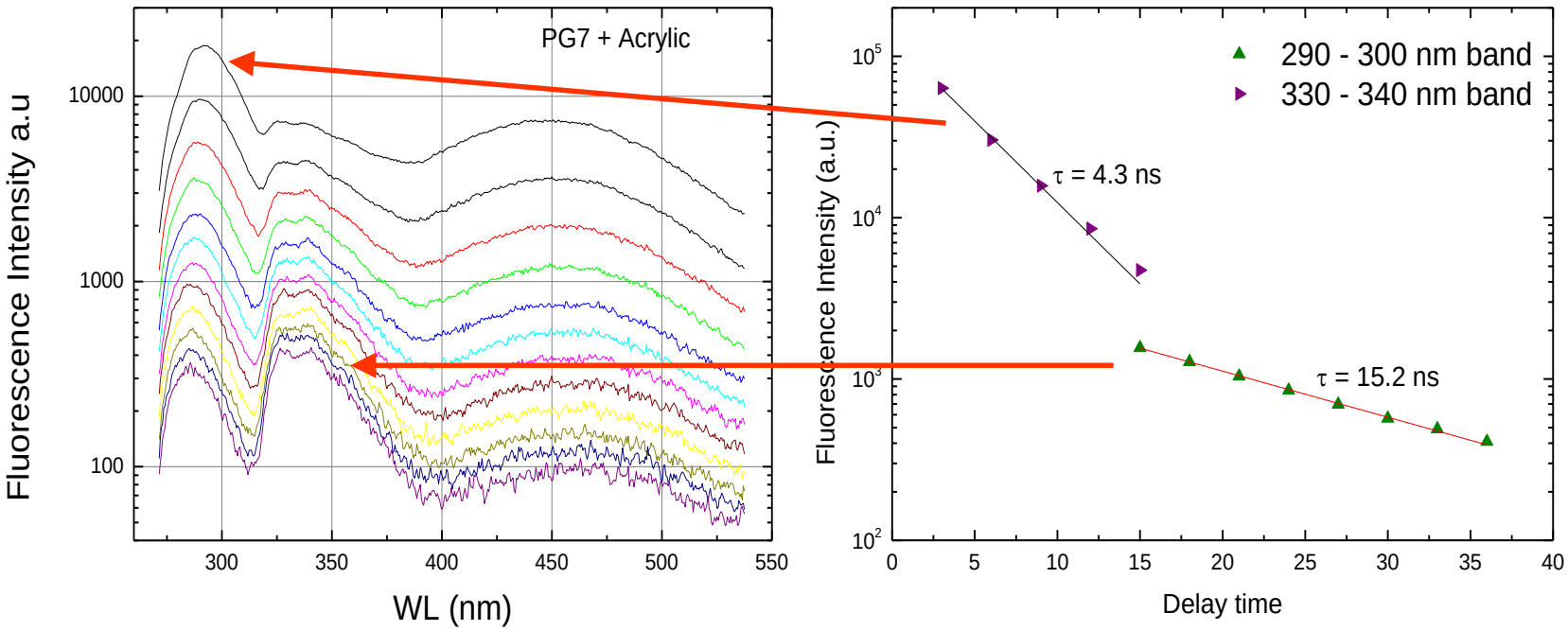
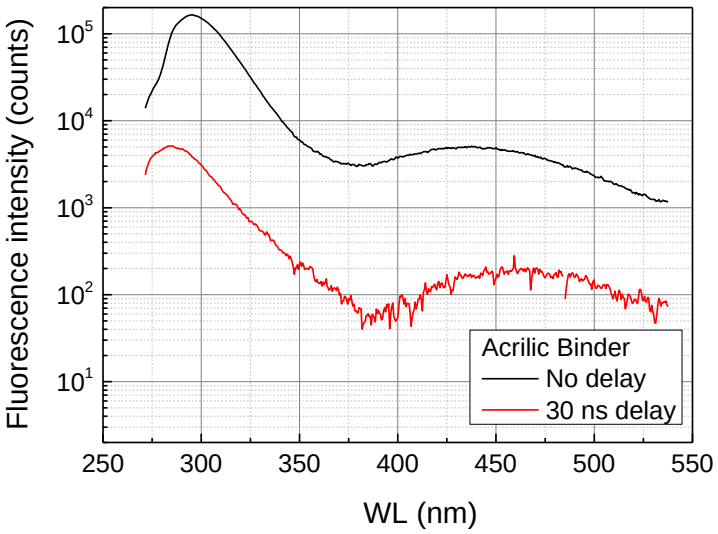


- Emission bands at 290-300 nm, with a rapid decay (τ = 4 ± 2 ns)
- Emission bands at 330-340 nm, with a slower decay (τ = 15 ± 2 ns)
- Emission bands at 400-500 nm can be noticed

Reference (lab) samples: PG7 and Acrylic

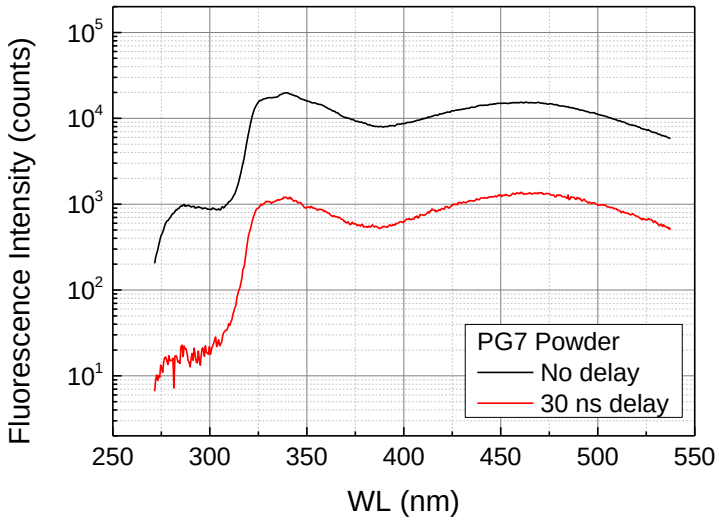
In order to identify the origin of the observed bands, spectra from samples containing one single component were recorded as well

Acrylic Binder



The acrylic binder shows a characteristic emission between 290-300 nm.

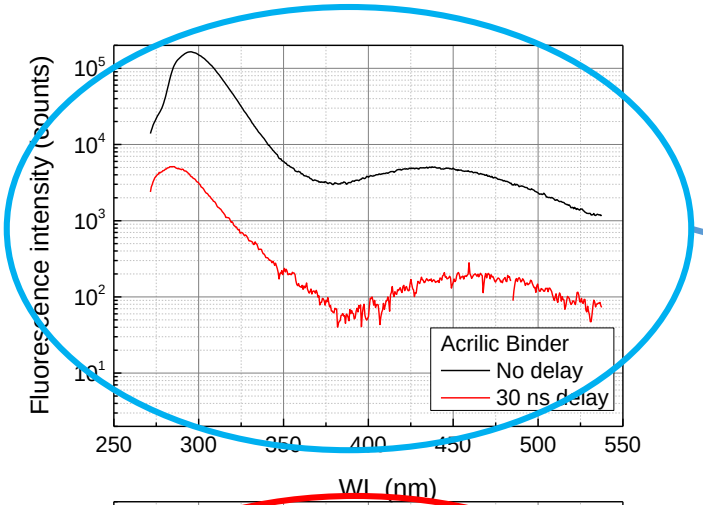
PG7 Powders

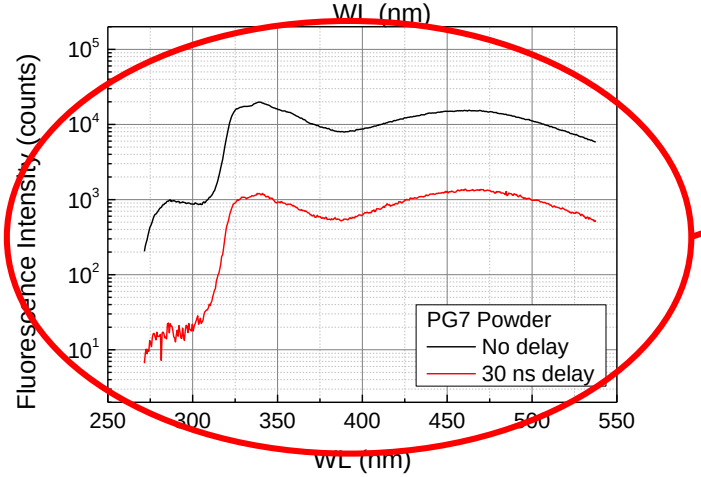


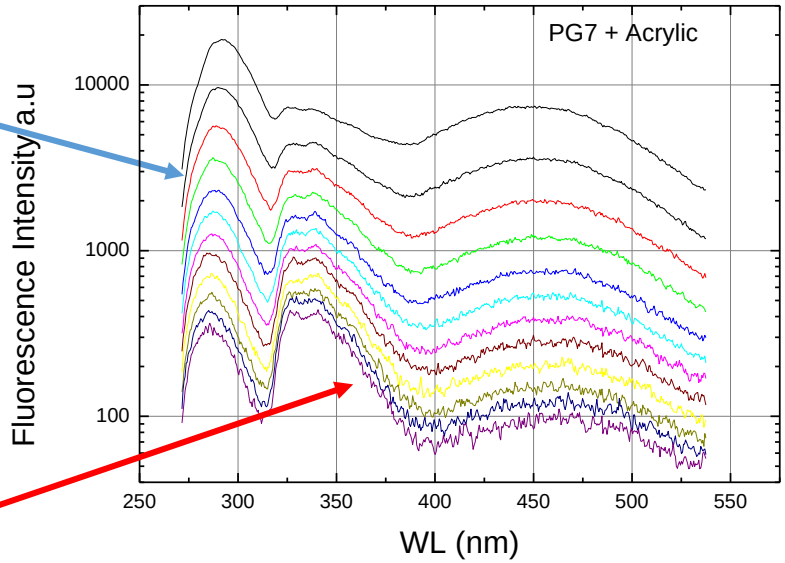
The PG7 powders show a characteristic emission between 330-340 nm.

Reference (lab) samples: Spectral Match

- Band at 294 nm with a rapid decay time it is attributable to **Acrylic Binder**
- Band at 340 nm with a slower decay time is attributable to **PG7 pigment**







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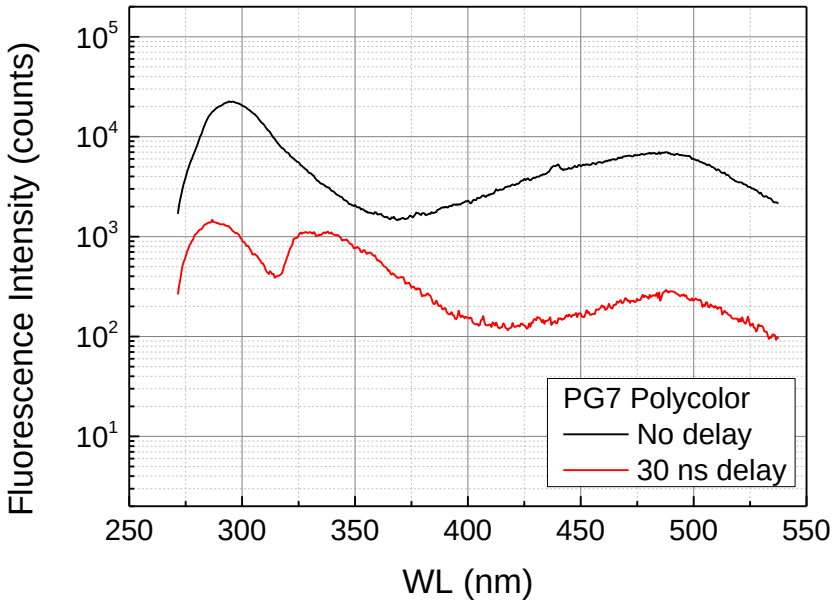
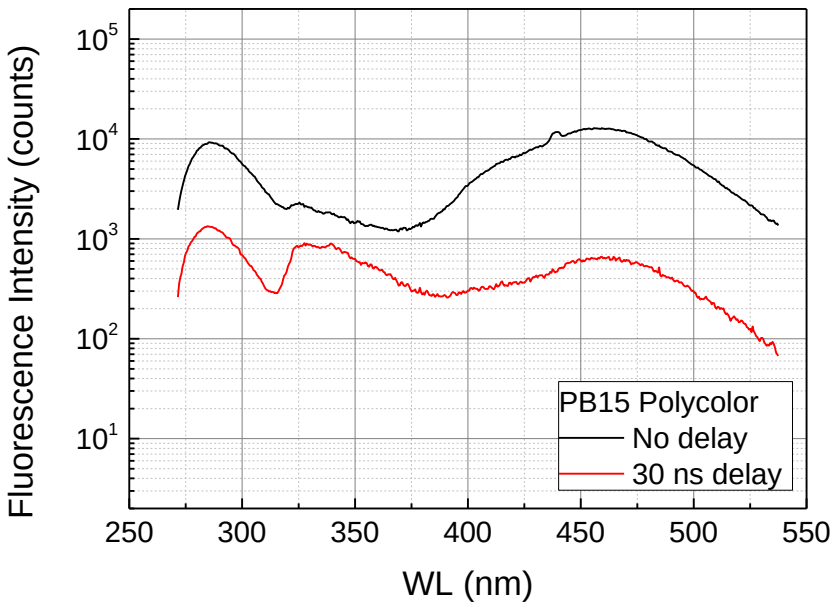
Commercial samples: PG7 and PB15

Green Phtalocyanine – PG7



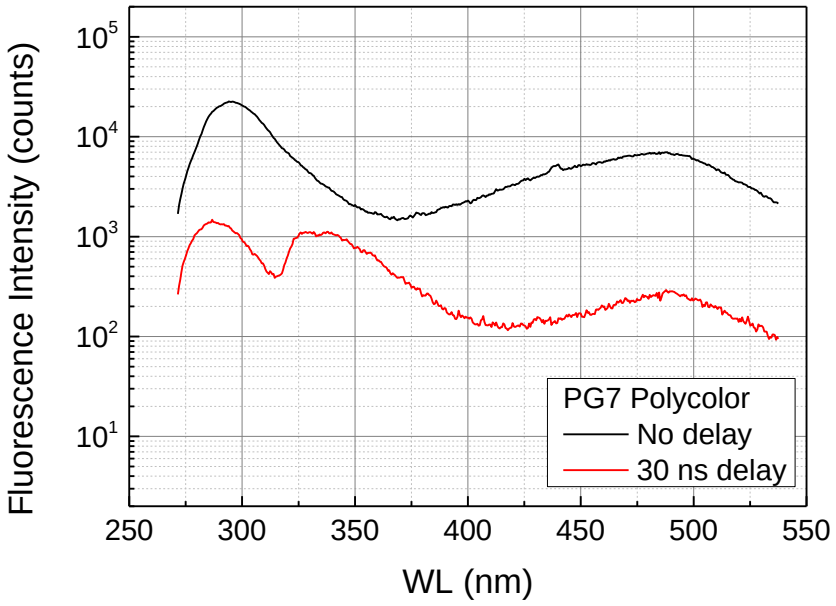
Blue Phtalocyanine – PB15



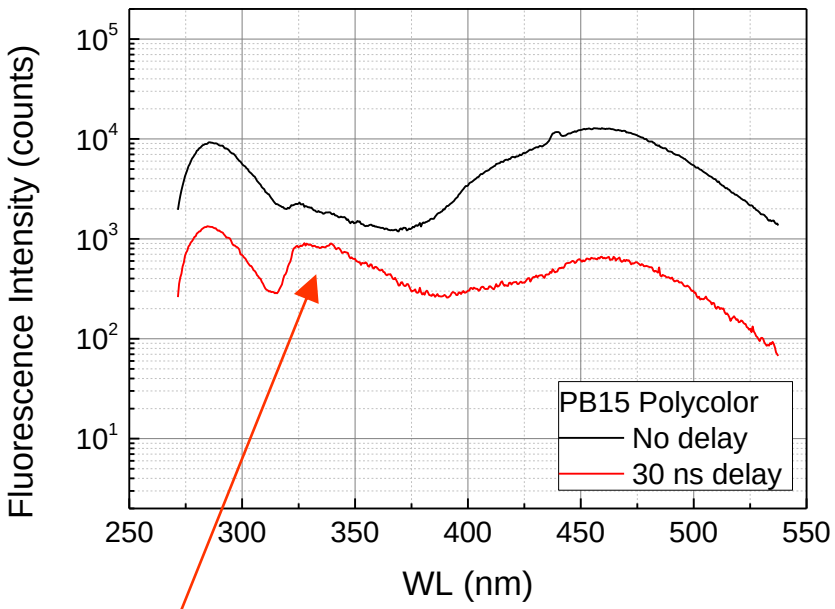
- Band at 290-300 nm → **Acrylic Binder**
- Band at 330-340 nm → **PG7**
- PB15 does not exhibit any characteristic emission band

Commercial samples: PG7 and PB15

Green Phtalocyanine – PG7



Blue Phtalocyanine – PB15



- Band at 290-300 nm → **Acrylic Binder**
- Band at 330-340 nm → **PG7**
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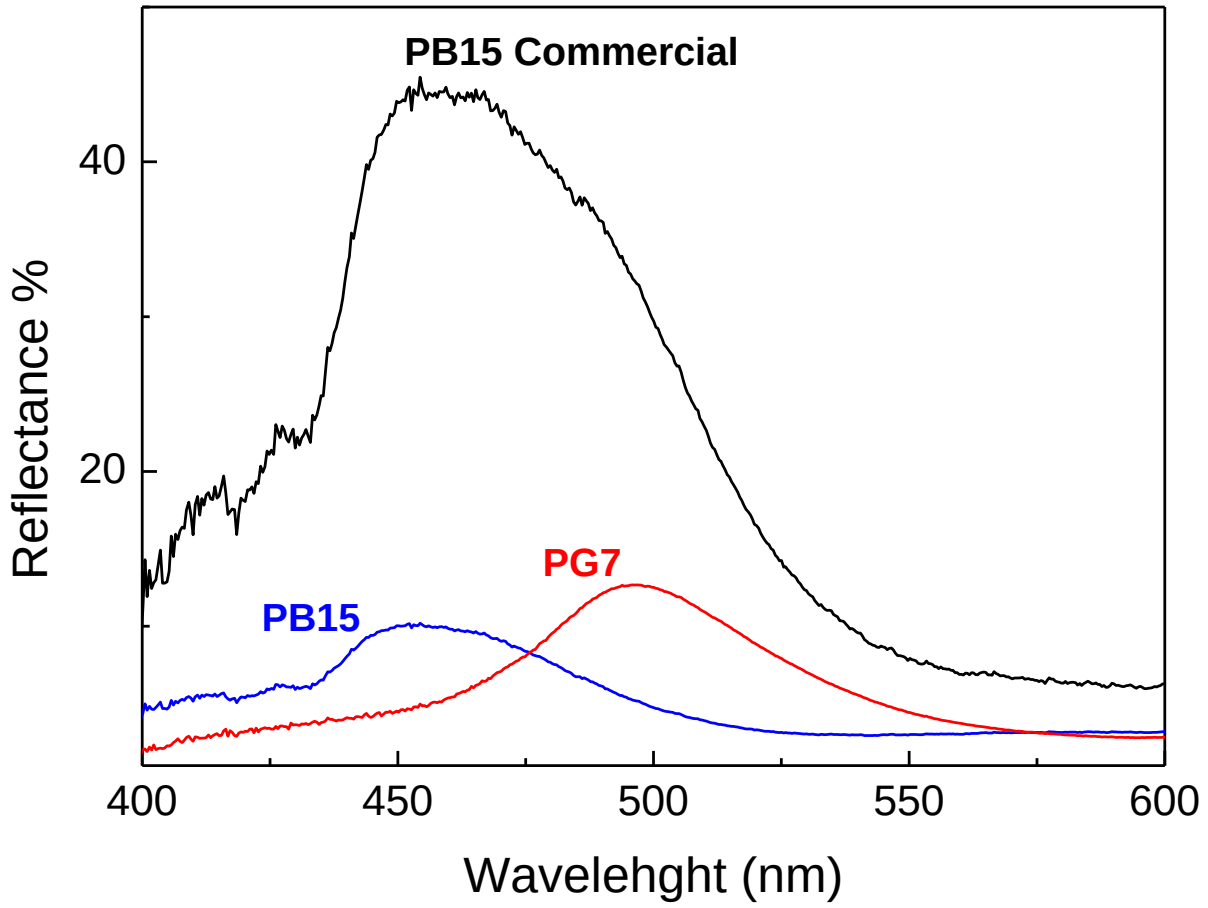
Does the Blue pigment contain the Green one as well?

Commercial PB15 samples: FORS

Fiber Optics Reflectance Spectroscopy (FORS) measurements



Commercial PB15 samples: FORS

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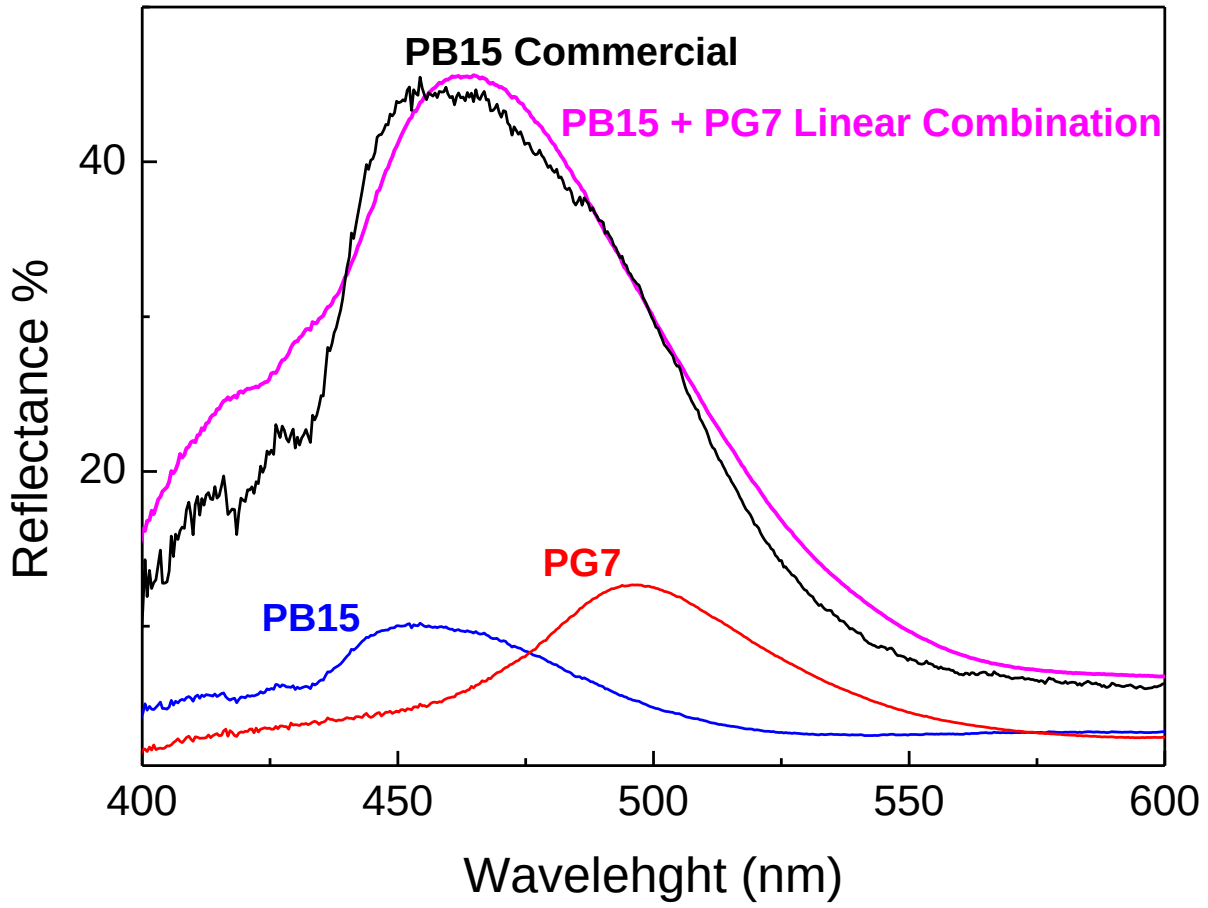

Yes, the commercial Blue pigment actually contains the Green one!

Conclusions

- ✓A combination of complementary diagnostic techniques is necessary in order to achieve an affordable compositional characterization

- ✓Time Resolved LIF measurements allow to identify different spectral contributions from pigments and binders by discriminating among their different decay times

- ✓The achieved classification agrees with the examined literature, and constitutes an good starting point towards the realization of a diagnostic characterization database for contemporary materials

Thanks for your attention