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A new version of the LEDμSF for *in situ* non-invasive spectrofluorimetric analyses of paintings.

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Abstract

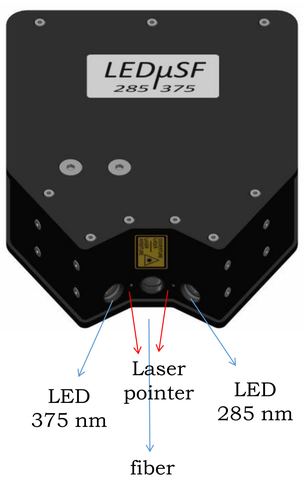
The development of portable and non-invasive techniques is becoming a priority for fragile objects and to answer the impossibility of sampling and moving artworks. One of the most recurring problems is the identification of organic materials (binders, dyes, …). Only few systems allow this. To overcome this lack, our team is developing a new small portable device, easy to use with a rapid analysis time to not disturb the preservation of artworks. The principle relies on the recording of fluorescence emission spectra emitted by materials when they are excited by specific UV Light Emission Diode (LED) sources. In preview, this new prototype is presented from a technical point of view and one example of application on old paintings is given.

Keywords: UV fluorescence, spectrofluorimetry, LEDs, reflectance, pigments, dyes

Mobile μ-spectrofluorimeter with UV-VIS-IR Light Emission Diodes for the characterization of the paintings materials

In 2014 a prototype of a portable LED μspectrofluorimeter (LEDμSF) has been designed for the identification of binders, dyes and pigments on paintings [1]. It has proven to be a complementary technique of reflectance spectroscopy for the characterization of colour matters such as pigments on medieval miniatures [2] or dyes on Japanese engravings [3]. In these cases, the exploitation of the emission fluorescence spectra obtained at **285** or **375** nm combined with reflectance spectra and X ray fluorescence analyses allowed us to draw the palette used by painters (vermilion, red lead, cochineal, indigo, nerprun…). The interpretation of fluorescence emission spectra was based on a comparison with the spectra of pigments or mixtures in our database (≥ 200 ref.), prepared in accordance with medieval or Japanese recipes.

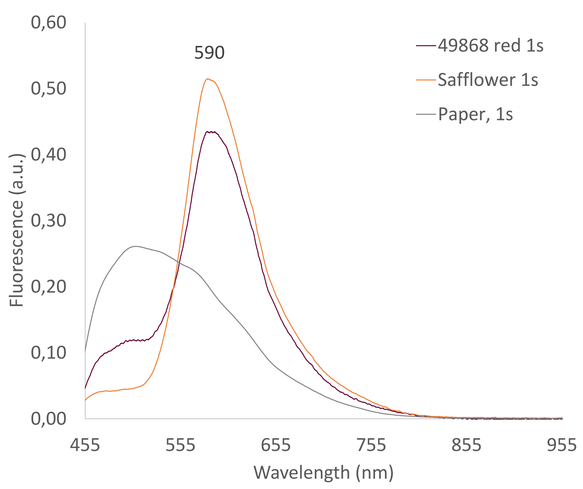
Four years later, a new prototype has been developed in collaboration with Freiberg Instruments (Germany) to increase the possibilities of identifications and applications. The new version allows recording both fluorescence and reflectance spectra by the addition of LED sources in the UV, VIS and IR ranges. Thanks to **nine small modules** (LED + filter) at **255**, **285**, **310**, **340**, **365**, **457**, **525**, **590**, **623** nm and a **white** LED, you can benefit of a better choice of the excitation sources in accordance with the investigated material. The emission and reflectance spectra are recorded with the Qmini II spectrometer (rgb photonics) wide VIS from 190 to 1100 nm. The working distance is about 4 cm. His weight is 0,8 kg and it necessitates 24 V plug in power supply or optional power bank.



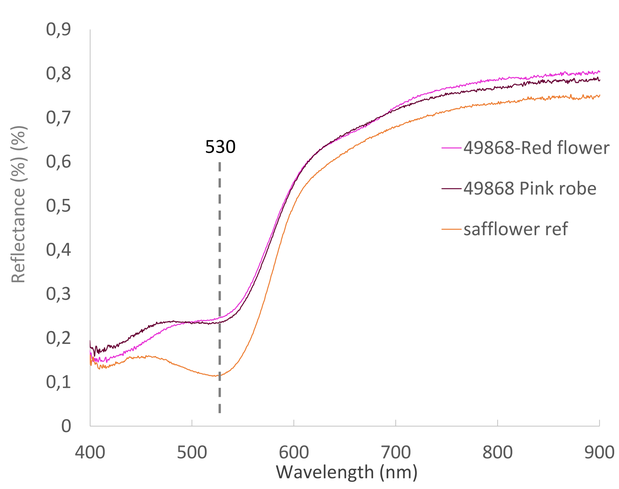
- ✓ ***Tactile screen to***: select the LED, adjust the analysis time, the power of the LED, the working distance (with two red lasers), take a picture of the analysis zone or visualize and record the spectrum.
- ✓ **9 modules (LED + filter)** are available and easily changeable thanks to a clip system (in orange on the picture).
- ✓ The system can be **held by hand** or fixed on a micropositioning stage on a tripod.

Application of the portable fluorimetry to old pigments

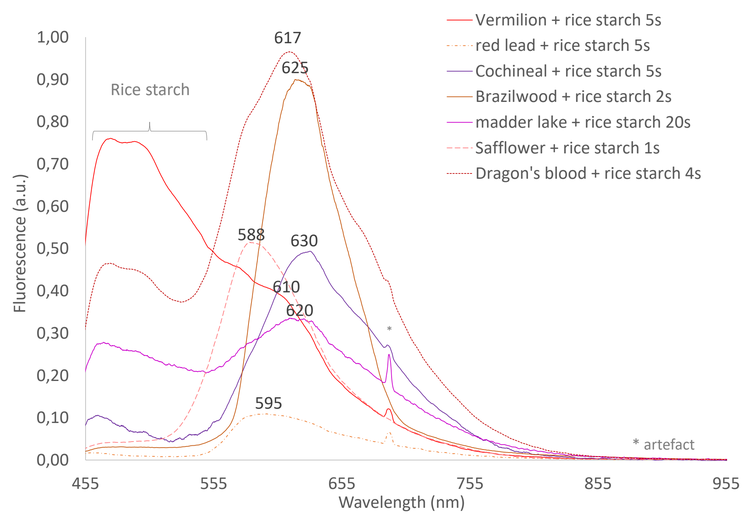
The 8 landscapes of the Eastern capital, Eisen (49868), 19e s.



Fluorescence emission spectrum under UV, Excitatrice: LED 375, filter at 455 nm, analysis time: 1s.



Reflectance spectrum in the VIS.



Fluorescence emission under UV of japanese reds, Excitatrice: LED 375

The LEDμSF was applied on five Japanese engravings kept in the Zaragoza Museum, 19e s. On the pink colour of the woman's kimono of the Eisen's print, the emission spectrum measured shows a maximum band at 590 nm which corresponds to the safflower dye in our database. This result has been confirmed by the reflectance spectrum recorded in the same point. The absorption band at 530 nm indicates the presence of carthamin which is the fluorophore of the safflower.
On the right, there are the emission spectra of the most red pigments used in Japanese's prints. The constitution of a database with reference emission spectra of each pigment mixed with the traditionnal binder (rice starch) was a first step. This work is in progress, especially to increase the database with mixtures and other combinations commonly used in the Japanese art [3].

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