MOLAB EQUIPMENT: DESCRIPTION

LABORATORY: CNR-ISPC

NAME OF THE INSTRUMENT

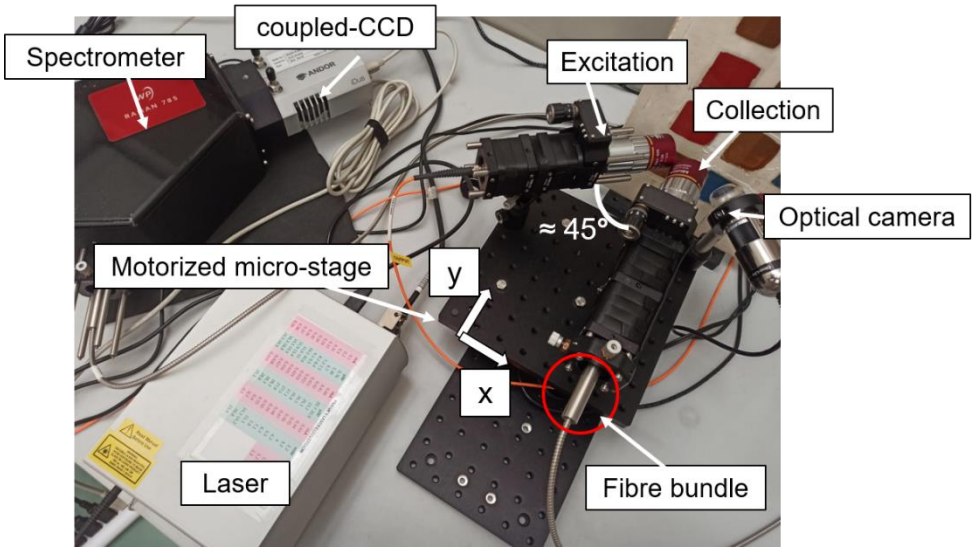
Portable micro-SORS prototype

GENERAL DESCRIPTION:

In Cultural Heritage field, Raman spectroscopy is one of techniques of choice for the identification of pigments (both inorganic and organic) used in paintings, frescos, and decorated objects. The advantage of this technique is its high chemical selectivity which leads to the ability to unequivocally identify the type of molecules, and consequently, the type of pigments. Raman data allows reconstructing the artist's technique, as well as the artwork state of conservation. In fact, in addition to the palette, information about the presence of degradation products or substances used for conservation purposes can be achieved. Commonly Raman spectroscopy provides information about the surface composition of the materials. In order to explore the internal portions non-invasively, a method has been developed—micro-Spatially Offset Raman Spectroscopy (micro-SORS)—able to detect the molecular composition of compounds located below the surface, within the microscale resolution. The Raman spectrometer available at MOLAB is a portable micro-SORS prototype, which allows the simultaneous acquisition of i) conventional Raman spectra, providing compositional information of the object surface, and ii) micro-SORS spectra, acquired at micrometric distances (offsets) from the laser incidence point, for the detection of Raman photons generated deeper within the objects and emerging laterally on the surface. Micro-SORS technique impact in the field of Cultural Heritage relies in the ability of partially reconstructing the painted layer sequence and identifying degradation products hidden underneath the surface.

TECHNICAL DESCRIPTION:

The instrument consists of a WP785 spectrometer (Wasatch Photonics), coupled with an iDus DU4011A-BR-DD CCD (Andor), and a 785 nm wavelength diode laser (Innovative Photonic Solutions - IPS) with aN excitation power ranging from 0.76 µW to 30 mW. The spectral resolution of the spectrometer is 8 cm^{-1}, and the spectral range is 100-3050 cm^{-1}. Two 10x long-working distance objectives (Mitutoyo; NA 0.26 – WD 30.5 mm) are used as excitation and collection optics. The laser-focusing objective is positioned at an angle of approximately 45° to the sample plane, and the calculated diameter of the laser spot is about 20 µm. A camera (DinoLite) is employed to observe and select the portion of the sample to be measured, and a micro-stage (Thorlabs M30XY) is positioned under the optical system, allowing precise sample alignment and focusing operations with high accuracy. The entire system is mounted on a tripod. Offset distances are achieved through the use of a micro-sized optical fiber bundle (Armadillo SIA - LV), enabling the simultaneous acquisition of both conventional and micro-SORS spectra (up to 15 spectra, with offsets ranging from 37 µm to 525 µm). This feature is beneficial for in-situ analyses as it guarantees the stability of the system and fast measurement times (micro-SORS sequences acquired in a matter of seconds or minutes). The acquisition of spectra is controlled by LabVIEW software.



Scheme of the prototype with indication of different components.

FURTHER INFORMATION:

- Mosca, S., Conti, C., Stone, N. and Matousek, P., 2021. Spatially offset Raman spectroscopy. *Nature Reviews Methods Primers*, *1*(1), 21.
- Conti, C., Botteon, A., Colombo, C., Pinna, D., Realini, M. and Matousek, P., 2020. Advances in Raman spectroscopy for the non-destructive subsurface analysis of artworks: Micro-SORS. *Journal of Cultural Heritage*, *43*, 31.

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