Laser remote and in situ spectroscopic diagnostics to CH surfaces

R. Fantoni, L. Caneve, F. Colao, M. Ferri De Collibus, M. Francucci, M. Guarneri, V. Spizzichino
ENEA, FSN-TECFIS, Frascati, Italy

O. Santorelli
ENEA guest

ABSTRACT: Optical and spectroscopic techniques offer unique possibilities for non-destructive or micro-destructive characterization of painted Cultural Heritage surfaces. The development of fast laser scanners in combination with sensitive CCD detector gave the chance to design and operate portable systems suitable to *in-situ* an remote spectroscopic imaging. Different prototypes have been developed and patented to collected reflectance and fluorescence images excited at different ultraviolet and visible laser wavelengths, Raman and LIBS signals. Portable integrated instruments suitable for operation at different distance from a 1.5 to 30 m, have been assembled and operated in laboratory on multilayered samples and in field campaigns on CH painted surfaces carried out within the COBRA and ADAMO regional projects. Results obtained on painted surfaces on monuments in Latium will be presented demonstrating the potentiality of combined in situ use of optical and spectroscopic tools in solving specific CH characterization problems.

1 INTRODUCTION

The preservation of CH surfaces requires suitable material diagnostics. CH surfaces have been produced on very different substrates, some of them very fragile, and often at a monumental scale (large size) with limitation of access (remote view). CH surfaces can be located in hostile environments (underwater) or must be examined in dangerous situations (after earthquakes, wars) which asks for complex interventions. There was a definite need for *in-situ* and remote surface diagnostics on CH which was satisfied with the laser break-through, i.e. the introduction of laser scanners for non-invasive or micro-destructive interrogation of the surface, which made possible to perform:

- Optical measurements consisting of collection of sets of monochromatic images by multiple visible laser scanners to reconstruct 3D model with native color information. Laser reflectance is measured, i.e. backscattered and diffused signals. Data relevant to surface appearance and morphology are acquired [1].
- Spectroscopic measurements consisting of space resolved collection of spectra containing information on surface layers. Most used laser spectroscopies are LIF [2], Raman [3], LIBS [4], with possibilities of time resolved detection. Data relevant to surface elemental and aggregate composition are collected. Possibility of subsurface analysis or stratigraphy is offered by some techniques.
- Joint application of different remote and *in-situ* diagnostics (e.g. thermography, XRF, PIXE, LIBS, Raman), with point detection or imaging capabilities.

The monochromatic laser beam interaction with a surface may cause different phenomena, with a probability depending on the incoming power for surface unit (irradiance), which determines the final energy balance. Together with partial radiation absorption, at growing irradiance, we may encounter: Back Scattering (BS) at the same wavelength as the exciting beam;