A. Materials analysis with Optical Spectroscopy

LIBS:

Laser Induced Breakdown Spectroscopy enables the determination of the elemental composition of materials on the basis of the characteristic atomic emission from a micro-plasma produced by focusing a high-power laser on, a solid surface. LIBS has been used in a wide variety of analytical applications for the qualitative, semi-quantitative and quantitative analysis of materials. It is rapid, non-destructive and can be used in-situ, therefore its application in the field of cultural heritage is considered very useful.

Objective of this module is to demonstrate the analytical capabilities of LIBS in the field of cultural heritage. Following a brief introduction in the main physical principles of the technique, and instrumentation aspects, participants will use LMNTII^{+} (eLemNT-II plus) a mobile LIBS instrument, especially developed for CH applications, to analyze materials on various model samples but also on selected real objects.

Raman:

Raman spectroscopy is a well-known analytical technique that probes vibrational and other low-frequency modes (motions) in molecules and materials. As a result, it provides an accurate look into chemical bonding, thereby enabling identification of various types of materials, both inorganic and organic. The technique is rapid, non-destructive and can be used in-situ, with increasing applications in the field of cultural heritage, for example, in the identification of pigments and minerals, binding media and varnishes, corrosion and degradation products. It features high sensitivity and specificity enabling analysis of a wide variety of organic, inorganic and bio-materials, often directly on the object under study, non-invasively, at short times and with superb spatial resolution when the analysis is performed on a Raman microscope.

Objective of this module is to demonstrate how Raman microscopy is used as an analytical and diagnostic tool in the field of cultural heritage. Following a brief overview of the main physical principles and basic instrumentation of Raman spectroscopy, measurements will be conducted on a mobile Raman micro-spectrometer. Participants will study model samples and real objects,

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collecting Raman spectra, learning how to extract analytical information and evaluating practical aspects of the technique.

B) Optical coherence metrology for structural diagnosis

Optical coherent metrology is the measurement of differential displacement of surface points with optical laser interferometry techniques. Holographic interferometry records phase changes of an expanded laser beam in higher spatial resolution photosensitive mediums. Being a non-contact and non-destructive optical method holographic Interferometry allows for qualitative and quantitative structural analysis of the examined objects. It is a safe, full-field technique using divergent beams and it is independent of the shape, surface texture, and complexity of the examined materials. It shows the surface response to hidden active defects, threatening environments and treatments, by visualizing rapidly the surface reaction to external perturbations. In-situ monitoring in real-time conditions, risk priority maps, structural documentation and routine impact assessment, before or after treatment, transportation, and handling are holographic Interferometry's exploited applications.

Objective of the module is to demonstrate the diagnostic potential of interferometric techniques as regards the visualisation and assessment of invisible and hidden structural defaults and problems in the bulk of objects and structures and the evaluation of their structural condition in relation to their environment. Following a brief introduction to the main physical principles of the technique, lab demonstrations will be carried out with DHSPI, a portable instrument, developed at IESL-FORTH. In the lab session the participants will have the chance

a) to get an overview of conventional optical holographic interferograms and generation of optical three-dimensional holograms,

b) to record digitalholographic speckle interferograms of technical samples with known defects in order to evaluate their structural condition and c) to simulate microclimate conditions in environmental chamber in order to assess the influence of environmental changes to the objects/surfaces on the basis of their optical coherence response to abrupt changes of relative humidity and temperature.

C) Multi spectral imaging and mapping

Spectral Imaging is based on the fact that materials absorb, reflect and emit light in a manner that depends on their molecular composition and shape. Multi-spectral imaging combines a high spatial resolution image with multiple point reflectance spectroscopy, enabling the detailed mapping of the individual layers (varnish and paint) that compose an artwork. The artwork is examined in a wide range of spectral bands (350 nm– 1200 nm) expanding thus the imaging potential of the object to spectral areas in which the human eye is not sensitive, namely the

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ultraviolet (350 nm- 400 nm) and the near infrared (700 nm- 1200 nm). In these spectral ranges light penetrates matter in variable ways revealing information from different layers of the object. In addition, in the visible region spectral imaging enables the analysis with higher spectral resolution (13 bands) than the human eye (3 bands), enhancing the differentiation of pigments/layers with similar color perception. Consequently, the artworks can be studied stratigraphically, revealing thus information on their history, composition and structure as well as on their restoration interventions.

Objective of this module is to demonstrate the analytical capabilities of Multi Spectral Imaging in the field of cultural heritage. In this session, a brief introduction to the main physical principles of the technique will be presented, followed by a demonstration of the analysis on selected samples. Multi-spectral images will be collectedwith IRIS, a portable instrument developed at IESL-FORTH.

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