MIXING THE MICROSCOPIES
An Insight Over the Capabilities of the Correlative Microscopies

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SUMMARY

- Correlative Microscopy – a definition
- CLEM – Correlative Light to Electron Microscopy
- CPEM – Correlative Probe and Electron Microscopy
- Correlative Raman and Electron Microscopy
- Correlative X-ray Tomography and Electron Microscopy
- Towards a multi-scale 3D reconstruction
CORRELATIVE MICROSCOPY – The definition

DEFINITION

Analysis of the same Region of Interest (ROI) through different types of microscopy

OBJECTIVE

To correlate on the same ROI the distinct information obtained from each microscopy
CLEM (Correlative Light – Electron Microscopy)

Optical Microscopy

Electron Microscopy
CLEM (Correlative Light – Electron Microscopy)

Surface earthy layer and black pigment of vegetable origin

White containing Zn, Ti and Ba

Imprimitura containing BaSO₄ grains

Preparatory layer made of glue and chalk

Pictorial stratigraphy of a contemporary picture from GNAM (Roma) – Courtesy of Dr. M.P. Sammartino (Dip. Chimica, Univ. La Sapienza)
CLEM (Correlative Light – Electron Microscopy)

Fluorescence Microscopy

Information about the cellular function

Electron Microscopy

Information about ultrastructure
CLEM (Correlative Light – Electron Microscopy)

Zeiss Shuttle & Find Sample Holder

Candida albicans' Hyphae
(prof.ssa D. Uccelletti – Dip. Biologia e Biotecnologie, Università La Sapienza Roma)
CPEM (Correlative Probe – Electron Microscopy)

**Atomic Force Microscopy**

High resolution on Z
Information about mechanical, electrical and magnetic properties

**Electron Microscopy**

High resolution range (mm – nm) & Fast Imaging
Element Analysis (EDX)
A simple way to correlate the two microscopies is to draw a large maker near the ROI by the Focus Ion Beam.
**LiteScope™ is a small AFM module mountable on the SEM through an adaptor**

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Graphene on Silicone Carbide

Jan Kunc, MFF UK, Czechia

CPEM (Correlative Probe – Electron Microscopy)

Cells conjugated with nanoparticles

Marco Cassani, ICRC-FNUSA, Czechia
RAMAN – Electron Microscopy

Raman Spectroscopy

- Identification of molecules, allotropes and polymorphs
- Determination of the level of crystallinity and orientation

Electron Microscopy

- High resolution range (mm – nm) & Fast Imaging
- Element Analysis (EDX)
RISE™ Microscopy
Correlative Molecular and Ultrastructural Imaging

RAMAN in SEM characterization of the Graphene

Hollricher et al., Microscopy Today 22 (2014) pp. 36-39

NANOINNOVATION 2020 16.09.2020 Roma
X-Ray Tomography – Electron Microscopy

**X-Ray Tomography**
- Non-destructive
- Large field of view
- Voxel resolution until 40 nm

**Electron Microscopy**
- High resolution
- Element Analysis (EDX)
- Focused Ion Beam
Multiscale characterization of a ceramic solid oxide fuel cells

True color images and localization of macroscopic failures

Localization of the porous system and all the functional layers. Porous fraction and tortuosity can be also computed.

Identification of the three phases of the anode (Ni – YSZ – pores). Detailed 3D reconstruction by FIB-SEM tomography.

EDX and phase identification by SAED analysis.

Characterisation of cuticular inflation development and ultrastructure in Trichuris muris

Research of the ROI through the MicroCT

The ROI is trimmed to the ultramicrotomy and the ultrastructure is analyzed by SEM and TEM

O’Sullivan et al., Scientific Reports 10 (2020) 5846
Towards The 3D Multi-scale Reconstruction

Characterisation of the porosity for a heterogeneous shale rock

Ma et al., Energy 181 (2019) 1285-1297

It’s possible to correlate not only a 2D ROI, but also expand the analysis to a volume
SPECIAL ISSUE
"Recent Advances and Applications of Electron and X-ray Beams for Multiscale Tomography"


DEADLINE: 10 October 2021