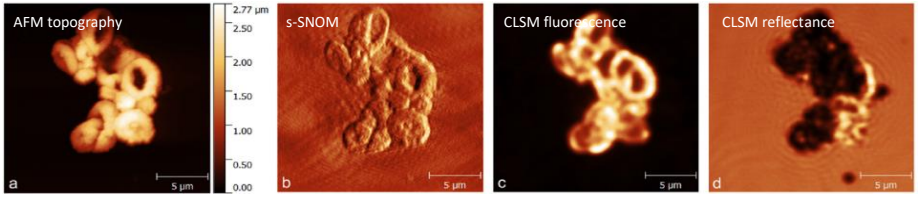
Center for Microscopy-Microanalysis and Information Processing

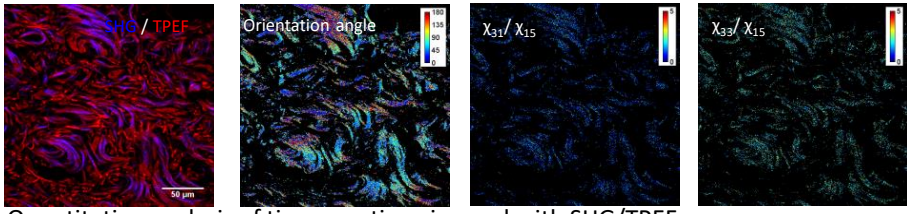
Major research projects

- 2 FP7 contracts: BioElectricSurface (2008-2011) & LANIR (2012-2015)
- national research grants in the last 5 years:
  - Understanding Membrane Dynamics and their Implications for Cancer with Correlative Optical Nanoscopy and Artificial Intelligence, Romania –Norway project (2021-2023)
  - Correlative optical imaging in the far-field and near-field regimes: technical developments and applications (2018-2020)
  - Label-free quantitative microscopy based on second harmonic generation at nanoscale (2018-2020)
  - An experimental machine intelligence framework for the automated differentiation of healthy, dysplastic and malignant tissues based on multiphoton microscopy datasets (2017-2018)
  - Quantitative nanoscopy for the characterization of biological tissues (2017-2018)
  - Correlation and integration of microscopy and nanoscopy data by advanced computer vision methods (2015-2017)
  - 8 bilateral international cooperation projects

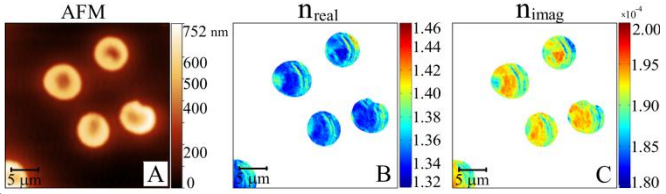
Research results in bioimaging and biophotonics



Polyelectrolyte nanocapsules for drug delivery applications



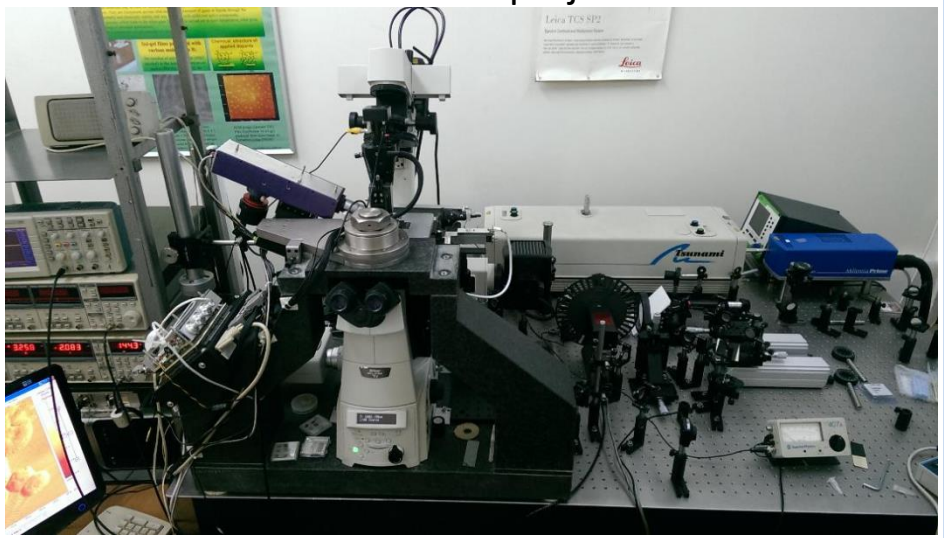
Quantitative analysis of tissue sections imaged with SHG/TPEF
S.G. Stanciu et. al. Sci. Rep. 7:15476 (2017)
R Hristu et. al. J. Biophoton. 10:1171-1179 (2017)



Refractive index mapping on erythrocytes

Major technical achievement

in the frame of the two FP7 projects



The multimodal microscopy system includes:

Far-field techniques

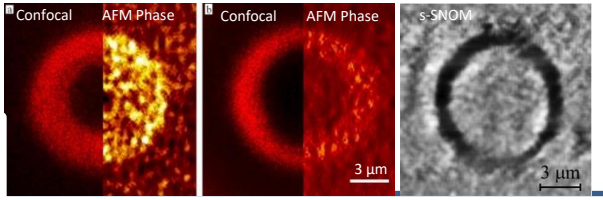
- confocal laser scanning microscopy (CLSM): reflectance and fluorescence
- multi-photon laser scanning microscopy (MPM): two photon excited fluorescence (TPEF) & second harmonic generation imaging (SHG)
- label free super resolution transient absorption microscopy

Near-field techniques

- scattering scanning near-field optical microscopy (s-SNOM)
- fluorescence SNOM
- SHG-SNOM

Scanning probe techniques

- atomic force microscopy (AFM): tapping & contact
- magnetic force microscopy



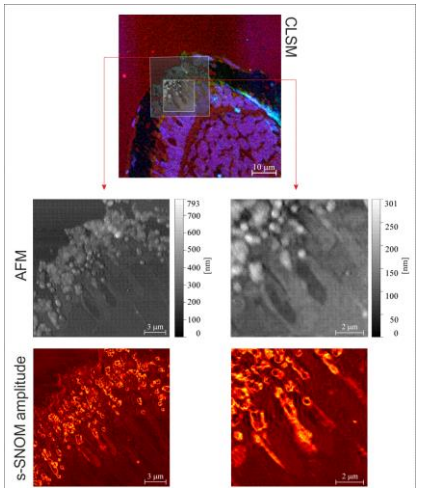
Surface charge imaging on hidroxyapatite

www.cmmip-upb.org

Future research project: combining correlative multimodal imaging with machine learning

Correlative Multimoda Imaging

- The field of correlative multimodal imaging (CMI) for life sciences is gaining increasing interest
- CMI combines two or more distinct imaging modalities to collect complementary information about the same region of an investigated specimen.
- CMI provides multidimensional information about a sample's structure, its dynamics, function and chemical composition.
- Because no single imaging technique can reveal all these details, CMI is the only way to understand biomedical processes and diseases holistically.
- A bottleneck of current CMI approaches that incorporate emerging imaging techniques (e.g. nanoscopy techniques) is connected to data interpretation issues which occur due to the limited body of work available with latest-hour technologies.



Zebrafish retina investigated at micro- and nanoscale with complementary imaging modalities (Stanciu et al, Biomed. Opt. Express)

Deep Learning

- Deep Learning, the emerging method for the utilization of big data in machine learning, took the realms of medicine and microsopy by storm
- Furthermore, Deep Learning has been recently demonstrated as a solution to merge distinct information categories (microscopy images and genomic data) to predict patient outcomes with better precision than human experts
- Such frameworks could be extended in the future to exploit in parallel also information generated from wearables, smartphones or internet-of-things devices

CMMIP-UPB will develop novel approaches that combine Correlative Multimodal Imaging and Deep Learning **(i)** to enable the accurate interpretation of biological and biomedical information collected at nanoscale with emerging modalities, and **(ii)** to enable next-generation applications for disease prevention, diagnostics and treatment that simultaneously exploit multiple distinct information categories.