Multidimensional imaging of Bio/Inorganic samples combining HRSTEM/X-EDS, SEM-SBF, NanoSIMS, µ-CT, APT and GD-OES

P. Le Coustumer[1*] ; S. Lacomme[1] ; F. Decoeur[1] ; I. Svahn[1] ; E. Gontier[1] ; I. Strzeminska[2] ; M. A. Subirana[3], D. Schaumlöffel[3] ; H. Okutan[4] ; P. Moonen[5,6] ; W. Blanc[7] ; I. Martin[8] ; H. Francois-Saint-Cyr[9] ; P. Chapon[10]

1. Bordeaux Imaging Center, Université de Bordeaux, CNRS UAR 3420, INSERM US4, 33000 Bordeaux, France
2. GUERBET France, 95943 Roissy-Charles de Gaule, France
3. Université de Pau et des Pays de l'Adour, E2S-UPPA, CNRS, IPREM, Pau, France
4. Muğla Sıtkı Koçman University, Kotekli Campus, 48000 Mentese, Turkey
5. Université de Pau et des Pays de l'Adour, E2S-UPPA, CNRS, LFCR, Pau, France
6. Université de Pau et des Pays de l'Adour, E2S-UPPA, CNRS, DMEX, Pau, France
7. Institut de Physique de Nice, CNRS UMR 7010, 06200 Nice, France
8. CAMECA Instruments, Madison, WI, 53711, USA
9. THERMOFISHER, Waltham, MA 02451, USA
10. HORIBA JOBIN-YVON, 91120 Palaiseau, France

* corresponding author

Abstract for EuroBioImaging (https://www.eurobioimaging.eu/events/all-hands-nodes-meeting-in-torino-italy-/)

Irrespective of the scientific field under consideration, researchers need multi-scale imaging that combines sensitivity in elementary analysis with beams minimizing interactions or degradation of the sample, and requiring no sample preparation. To this day, were a universal technique checking all these boxes to be be announced, its availability still belongs to a dream. Modestly, through collaborations, we have obtained complementary –and sometimes correlative- images on different types of samples which combined high spatial resolution (1 nm) with high chemical sensibility (100 ppb). Samples were freeze-dried rat brain extracts containing a few ppb of gadolinium; an optical fiber whose core has been enriched with rare earth nanoparticles of some nm size; a limestone with a multi-dimensional pore network, from nm to several µm; or an altered non-conductive thin multilayer (some nm) glasses. We explored different solutions by combining dedicated sample preparation, multi-scale imaging and in- or ex-situ spectroscopy. The tools at our disposal will enable us to answer some questions facing our community. Thematic boundaries are becoming blurred, because of the added complexity of the samples due to their heterogeneity of scale, composition, structure and texture. In our approach, we present some success obtained by combining electron microscopy (HR-STEM/X-EDS or SEM-Serial Block Faces), nano-SIMS, X-ray micro tomography (µCT), Atom Probe Tomography (APT) and Glow-Discharge Optical Emission Spectroscopy (GD-OES). Our conclusion, based on these experiments, is that by combining analytical and imaging approaches, it is possible to obtain data that has yet to be validated and exploited. For this reason, we believe that dialogue between specialists and scientists from all backgrounds should be encouraged.