SISSI-Nano: the nanoresolved infrared endstation at Elettra synchrotron facility

Federica PICCIRILLI – *Elettra Sicrotrone Trieste*

Since 2019, the SISSI-Nano branch is dedicated to infrared studies at the nanoscale and represents the most recent upgrade of SISSI infrared beamline at Elettra Sincrotrone Trieste. The experiments performed at SISSI-Nano are related to different research fields from biophysics and bioengineering to cultural heritage. The end-station relies on a Scattering-type Scanning Near field Infrared Microscopy (s-SNIM) instrument (attocube systems AG), first coupled to a broadband Difference Frequency Generation (DFG) laser and a Quantum Cascade Laser (QCL), and more recently to the Infrared Synchrotron (IRSR) source. Nanoresolved infrared spectroscopy represents indeed an extremely powerful tool for the morpho-chemical investigation of nanostructures and since its first development, more than a decade ago, a growing number of successful applications on many different research areas have been proposed. In particular s-SNIM allows for label free chemical characterization at the nanoscale of organic and inorganic composite surfaces. Moreover, it can potentially allow the chemical analysis of materials subsurface layers, proposing itself as the optimal technique for the study of composite materials. The SISSI-Nano endstation will be here presented with particular emphasis to relevant results obtained during the last years in the field of biophysics.

First the study of ferritins, proteins responsible for storing and controlling iron release in cells, adsorbed on asbestos fibers will be shown, with the aim to unravel the role of iron in driving different bonding pathways of ferritins on fibers. S-SNIM spectroscopy and nanoimaging with PsHet detection were here fundamental to establish the role of iron as active reaction partner. It is shown that while iron depleted proteins tend to adsorb onto the fiber covering it like a skin, the iron rich one form is adsorbed not only on the external surface of the fiber but can also rich its interior, intercalating itself between the fibers rolled layers. The second experiment shows the loading of DNA molecules on clay nanotubes, candidates as carriers for drug delivery and gene transfer. s-SNIM data show that DNA loading occurs mainly onto the external surface of nanotubes. Moreover, in order to make the adsorption possible, DNA molecules have to rearrange their structure at a significant extent involving not only the breakage of the double helix but also the exposure to charged side chains to nanotubes surface.