Infrared bio-spectroscopy: from Macro to Nano scale on the molecules of life

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The no-damaging nature of the infrared (IR) light is a unique feature in Synchrotron Radiation (SR) facilities, which allows the safe investigation of vibrational and vibro-electronic transitions for a wide variety of materials. Hence, the applications of IR spectroscopy cover a wide range of research fields including biochemistry, cultural heritage, forensics, geology, polymer-science, in-vitro live cell analysis, biomedical diagnostics, and many others. SISSI Chemical and Life Sciences Branchline at Elettra is optimized for analyses in the medium infrared energy range that matches the energy of the last majority of the molecular bonds present in organic matter, and it is particularly devoted to the study of biochemical and biophysical processes within live cells. The understating of the structure and behaviour of the macromolecules constituting the living matter, like proteins, lipids, carbohydrates and nucleic acids, i.e. the building blocks of life itself is of paramount interest of the scientific community and FTIR microspectroscopy can do it both in complex systems, as single cells, and in simpler ones, like solution or films. However, the spatial resolution associated to IR analyses has been limited up to now to the micrometer scale, ultimately imposed by diffraction in the far-field microscopy. In recent years, technical and scientific improvements have permitted to circumvent the diffraction barrier and to improve the spatial resolution of IR microscopy down to the nanometer scale. Nano-FTIR systems will allow obtaining chemical information with a spatial resolution not assessable with conventional far-field approaches, preparing the stage to a new era of experiments and scientific discoveries, bridging molecular properties to functional behaviour through mesoscale analysis.

The present lecture is intended to present the most relevant characteristics of IR synchrotron radiation and associated instrumentations, through exemplary experiments exploiting both diffraction-limited and sub-diffraction approaches.