BIOLOGICAL APPLICATIONS OF SYNCHROTRON RADIATION INFRARED SPECTROMICROSCOPY

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The field of infrared biological imaging covers a wide range of fundamental issues and applied researches such as cell imaging or tissue imaging. It continuously offers new opportunities to better understand cell interactions, cell micro-environment, tissue formation and diagnostic.

A synchrotron source (SR) has the capability of providing IR light through a 10 μm pinhole that is 2–3 orders of magnitude brighter than a conventional Globar such as those available in commercial FTIR instrumentation. This superior signal-to-noise ratio (SNR) allows collecting imaging with a spatial resolution down to the diffraction limit, or to allow analysis of thicker samples while maintaining good spatial resolution.

The availability of the infrared FPA detector and its recent installation at ultra-brilliance SR facilities around the world promises to extend the performance and overcome the existing limitations [1]. As an example FTIR microscopy with a FPA detector allows routine chemical imaging on individual cells in a few minutes only. The brilliance of SR IR sources may enhance the molecular signal obtained from such small biosamples containing reduced amount of organic matter. Molecular structure and function are strongly correlated. This aspect is particularly relevant in the case of proteins, which play important roles in cells biochemistry. Changes of structure may be easily detected in an IR spectrum and a cellular molecular marker may in fact be used to address a pathological status of tissues [2].

FPA detectors couple to SR sources may reduce data acquisition time from hours to minutes, improving the spectral quality and overcoming instability contributions sometime experienced at SR facillities [3].

Combining SR and array detectors we investigated individual cells obtained from a cell culture specifically developed for transmission FTIR imaging using either a Globar or a SR source. SR-IR source focalization was optimized time by time to control the energy distribution on the array detector.

I will show that access to IR absorption distribution from all organic contents of cells at 1×1 μm pixel resolution is possible only with high circulating current and, illuminating a limited number of pixels of a FPA's detectors to increase the signal-to-noise ratio of IR images [4].

High current SR rings are mandatory to collect FTIR images of biosamples with a high contrast in minutes. Within this framework there is really a brilliant future for SR IR microscopy and imaging, and important results in biological and biomedical applications are expected in the next years.

References

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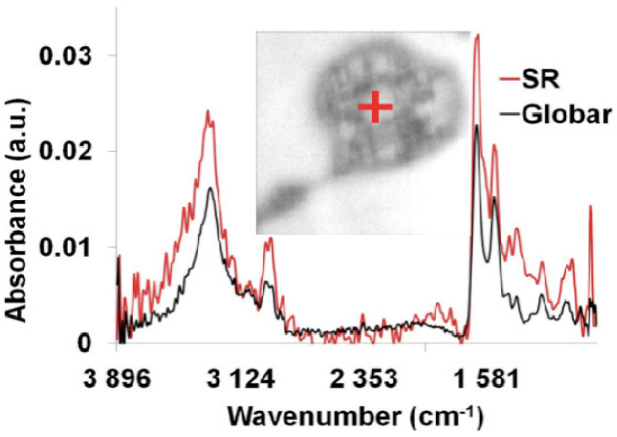

Figure 1. Comparison between FTIR spectra of individual cells collected with SR-IR at DAΦNE and a Globar source. Acquisitions were performed at 8 cm^{-1} spectral resolution with the 36X objective in the region indicated by a red cross on the visible image.