

SMIS beamline

NANO

ORGANISMS



TISSUES



CELLS



ORGANELLES



COMPLEXES



PROTEINS



ATOMS



SAMPLES

TYPES

- **Cells (fixed):** 2D cultures, primary cells, cell lines, yeast, bacteria, microalgae, protozoa...
- **Tissue sections**
- **Living Cells: in O-PTIR** (Optical Photothermal IR)
- **Virus**
- **Protein fibrils and complexes, fibers**
- **Organelles, vesicles**
- **Nanoparticles**

ENVIRONMENTS

- **O-PTIR:**
 - Compatible with glass, metals and IR transparent substrates
 - Compatible with microfluidic devices made of glass and IR transparent window
- **NanoIR:**
 - Flat, ultrasmooth gold substrates

OFFLINE INSTRUMENTS

- **Raman microscope:**
TFS DXR, 532, 633 and 780 nm lasers, 50x and 100x objectives, 1 μm resolution



- **Imaging IR microscope:**
Cary 620, 128x128 pixel Focal Plane Array detector to image large samples (mm^2 to cm^2 size) quickly with 20-30 μm resolution.



TECHNIQUE

SMIS is an infrared microspectroscopy beamline that is organized in two branches: **SMIS Micro** and **SMIS Nano**. The **SMIS Nano** branch gives spatial resolutions well below the diffraction limit of mid-IR. The **O-PTIR** technique (Optical Photothermal IR) gives 500 nm resolution and the **nanoIR** spectroscopy reaches 10-50 nm spatial resolution. The **NanoIR** instrument can be coupled to a laser source (900-1800 cm^{-1}) or to the synchrotron (700-1800 cm^{-1}) and can use sSNOM or AFM-IR modes.



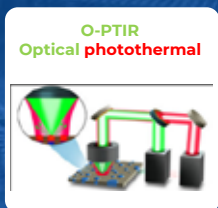
OPTIR, miRage



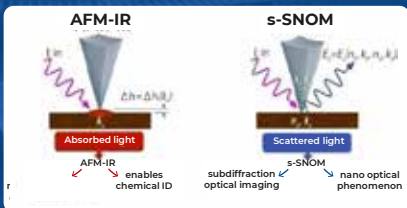
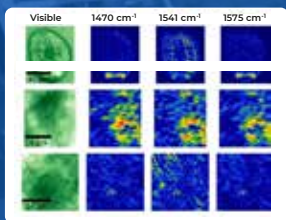
nanoIR, neaSNOM

Both techniques can be used in combination with infrared microspectroscopy for:

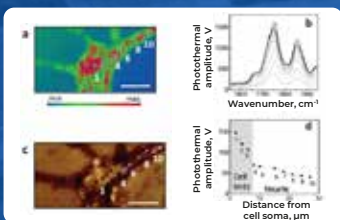
- ⌚ Quickly **image** samples at single wavenumber to locate molecules at sub-diffraction resolution
- ⌚ Spectral **Identification** of molecules



Mapping photosensitive lipids in human hair medulla with OPTIR



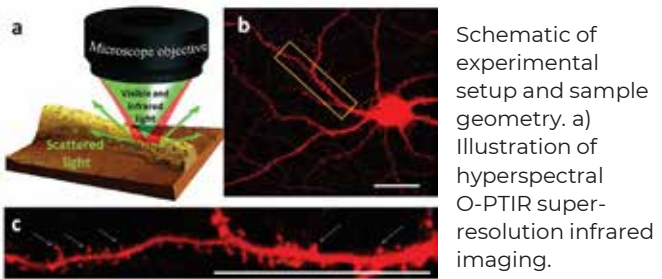
Amyloid conformation in Alzheimer disease primary neurons in OPTIR



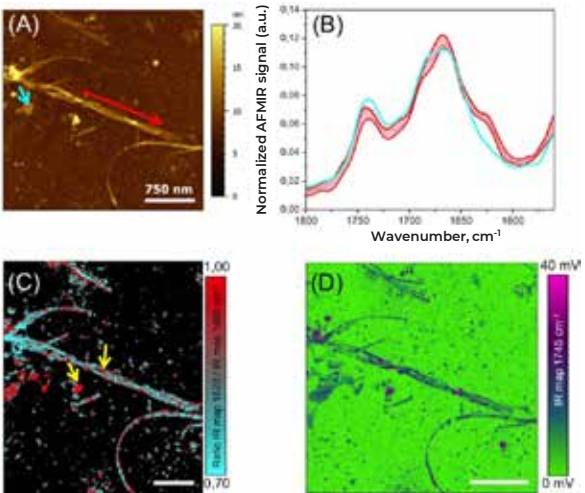
HIGHLIGHTS

Alzheimer's disease (AD) is a fatal neurodegenerative disorder associated with neuronal loss caused by the aggregation of amyloid proteins into neurotoxic β -sheet enriched structures, the amyloid plaque. However, the mechanism of amyloid protein aggregation in cells is still not well understood especially its first steps. Many challenges arise when studying the endogenous amyloid structures in neurons or in brain tissue: small size, complexity of the cell medium...

AD-related amyloid protein aggregation can be measured directly in neuron by OPTIR superresolution microspectroscopy at submicrometer resolution.



Measuring primary neurons with O-PTIR.



a) O-PTIR image of the neuron acquired at 1650 cm^{-1} (proteins) (b) OPTIR spectra. Scalebar $20\text{ }\mu\text{m}$. c) AFM image of the same primary neuron. D) OPTIR signal from the neuron cell body to the cell neurite

REFERENCES

- Nano-Infrared Imaging of Primary Neurons Raul O. Freitas, Adrian Cernescu, Anders Engdahl, Agnes Paulus, João E. Levandoski, et al. (2021) Cells, 10
- Super-Resolution Infrared Imaging of Polymorphic Amyloid Aggregates Directly in Neurons Oxana Klementieva, Christophe Sandt, Isak Martinsson, Mustafa Kansiz, Gunnar Keppler Gouras, et al. (2020) Advanced Science



More information on SMIS
publications web page

COMPLEMENTARY BEAMLINES

ANATOMIX: obtain three-dimensional X-ray tomography images of bulk volume samples at microscopic resolution.

NANOSCOPIUM: micro to nano morphology, elemental composition and chemical speciation.

DISCO: chemical imaging using auto-fluorescence microspectroscopy.

LUCIA: X-ray microprobe (μ -XAS, μ -XRF).



CONTACT

Ferenc Borondics

Beamline manager

✉ ferenc.borondics@synchrotron-soleil.fr

☎ +33 (0)1 69 35 81 92

Christophe Sandt

Beamline scientist, life sciences

✉ christophe.sandt@synchrotron-soleil.fr

☎ +33 (0)1 69 35 81 07

Health & Well-Being at SOLEIL



Link to the
web page

SOLEIL's Health and Well-being Scientific Section is composed of 30 scientific experts from different fields. Through collaborative and science-driven approaches, the Section offers the community a coherent portfolio of state-of-the-art techniques to serve scientific and societal health-related challenges.



L'Orme des Merisiers - Départementale 128
91190 Saint-Aubin - FRANCE
www.synchrotron-soleil.fr