Synchrotron macro ATR-FTIR microspectroscopy for high-resolution chemical mapping of single cells

Vongsvivut, Jitraporn (Pimm); Pérez-Guaita, D.; Wood, B. R.; Heraud, P.; Khambatta, K.; Hartnell, D.; Hackett, M. J.; Tobin, M. J.

2020

Vongsvivut, J., Pérez-Guaita, D., Wood, B. R., Heraud, P., Khambatta, K., Hartnell, D., ... Tobin, M. J. (2020). Synchrotron macro ATR-FTIR microspectroscopy for high-resolution chemical mapping of single cells. Proc. Of the 7th Asian Spectroscopy Conference (ASC 2020). doi:10.32655/ASC_8-10_Dec2020.43

<https://hdl.handle.net/10356/144295>

https://doi.org/10.32655/ASC_8-10_Dec2020.43

Synchrotron Macro ATR-FTIR Microspectroscopy for High-Resolution Chemical Mapping of Single Cells

Jitraporn (Pimm) Vongsvivut¹, D. Pérez-Guaita², B. R. Wood², P. Heraud², K. Khambatta³, D. Hartnell³, M. J. Hackett³ and M. J. Tobin¹

¹ Infrared Microspectroscopy (IRM) Beamline, ANSTO – Australian Synchrotron, 800 Blackburn Road, Clayton, Victoria 3168, Australia; ² Centre for Biospectroscopy, Monash University, Clayton, Victoria 3168, Australia; ³ Curtin Institute for Functional Molecules and Interfaces, School of Molecular and Life Sciences, Curtin University, GPO Box U1987, Perth, Western Australia 6845, Australia.

E-mail: jitrapov@ansto.gov.au

Abstract

Attenuated total reflection Fourier transform infrared (ATR-FTIR) spectroscopy has been used widely for probing the molecular properties of materials. Coupling a synchrotron infrared (IR) beam to an ATR element using a high numerical aperture (NA) microscope objective enhances the spatial resolution, relative to transmission or transmittance microspectroscopy, by a factor proportional to the refractive index (n) of the ATR element.

Fig. 1: The “hybrid” macro ATR-FTIR device, high-resolution chemical map of protein in single malaria-infected red blood cell, and *Analyst* journal cover featuring this work (from left to right).

This work presents the development of the synchrotron macro ATR-FTIR microspectroscopy at Australian Synchrotron Infrared Microspectroscopy (IRM) Beamline, and demonstrates that high quality FTIR chemical maps of single cells and tissues can be achieved at an enhanced spatial resolution [1]. The so-called “hybrid” macro ATR-FTIR device was developed by modifying the cantilever arm of a standard Bruker macro ATR-FTIR unit to accept germanium (Ge) ATR elements with different facet sizes (*i.e.* 1 mm, 250 μm and 100 μm in diameter) suitable for different types of sample surfaces (Figure 1). We demonstrated the capability of the technique for high-resolution single cell analysis of malaria-infected red blood cells, individual neurons in a brain tissue and cellular structures of a *Eucalyptus* leaf. The ability to measure a range of samples from soft membranes to hard cell wall structures demonstrates the potential of the technique for high-resolution chemical mapping across a broad range of applications in biology, medicine, environmental science and more.

Keywords: synchrotron infrared, ATR FTIR, spatial resolution, red blood cell, neuron, plant leaf

References:

- [1] J. Vongsvivut, D. Pérez-Guaita, B.R. Wood, P. Heraud, K. Khambatta, D. Hartnell, M. Hackett, and M.J. Tobin, “Synchrotron macro ATR-FTIR microspectroscopy for high-resolution chemical mapping of single cells,” *Analyst*, **144**, 3226-3238 (2019).