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High-Resolution Macro ATR-FTIR Chemical Imaging Capability at Australian Synchrotron IR Beamline and Its Applications in Food Science

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Abstract:

This work presents advances in high-resolution chemical imaging capability at Australian Synchrotron Infrared (IR) beamline, achieved through the use of an in-house developed synchrotron macro ATR-FTIR microspectroscopic device [1]. The device was developed by modifying the cantilever arm of a standard macro-ATR unit to accept germanium (Ge) ATR elements with different contact facet sizes (i.e. 1 mm, 250 µm and 100 µm in diameter). Coupling synchrotron-IR beam to the Ge ATR element (n=4) used in this device, has the effect of not only reducing the beam focus size (improving the lateral resolution) by a factor of 4, but also reducing the mapping step size by 4 times relative to the stage step motion. As a result, the macro ATR-FTIR measurement at Australian Synchrotron IR Beamline can be performed at minimum beam size of 1.9 µm using a 20x objective, and at minimum mapping step size of 250 nm, allowing high-resolution chemical imaging analysis.

While the large Ge facet size works well with soft materials that do not require high pressure to achieve a good contact, the small tips can provide higher pressure and allow measurements inside smaller regions with limited access suitable for hard and rough surfaces [1-2]. This macro ATR-FTIR device can also be coupled to a temperature control unit, allowing temperature-dependent study, as well as measurements that require a fixed temperature such as analysis of dairy products at 4 oC similar to the usual storage condition in a household fridge.

The development of the macro ATR-FTIR device has so far led to successful analysis of samples from a diverse range of research disciplinary. Key applications in food science to be presented include a range of dairy products (e.g. cheese and yoghurt), plants and vegetables.

References:

[1] V.K. Truong, M. Stefanovic, S. Maclaughlin, M.J. Tobin, J. Vongsvivut, M. Al Kobaisi, R.J. Crawford, E.P. Ivanova, "The evolution of silica nanoparticle-polyester coatings on surfaces exposed to sunlight," J. Vis. Exp. 116, e54309, 1-11 (2016).

[2] J. Vongsvivut, V.K. Truong, M.A. Kobaisi, S. Maclaughlin, M.J. Tobin, R.J. Crawford, E.P. Ivanova, "Synchrotron macro ATR-FTIR microspectroscopic analysis of silica nanoparticle-embedded polyester coated steel surfaces subjected to prolonged UV and humidity exposure," PLoS One 12, e0188345 (2017).

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