3D Tomographic FTIR Spectrochemical Imaging for Assessment of Nutrients in Arctic Sea Ice Diatoms


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We demonstrate the use of FTIR imaging for evaluation of the composition of single, whole and intact diatoms at low and high resolution, in 2D and 3D. To this end, data import, filtered back projection and 3D model export algorithms in MatLab™ were adapted for reconstruction of FTIR tomographic data. FTIR spectrochemical imaging allows detailed analysis of the distribution and abundance of compounds inside a single diatom on a sub-cellular level. Targets are selected individually, permitting species-specific examination, without need for laboratory culture.

In keeping with the adage “out of sight, out of mind”, the impact of microscopic organisms on life on Earth can easily be overlooked. Despite this, they play a major role in Earth’s ecosystems, and are critical to our understanding of the environment. Of particular interest are sea ice pennate diatoms, the dominant taxa during the vernal Arctic ice algae bloom. Ice algae provide the primary food source during early spring and are thus a key component of the Arctic ice-covered ecosystem, an ecosystem currently undergoing rapid change associated with climate warming.

High spatial resolution images were collected at the InfraRed ENvironmental Imaging (IRENI) beamline. For comparison, our in-house Agilent 670 IR spectrophotometer equipped the 620 IR microscope and 64×64 pixel Focal Plane Array (FPA) detector was used for thermal source imaging. Attenuated Total Reflection (ATR) FTIR images were collected using an Agilent slide-on Ge crystal.

The advent of FTIR tomography brings a new dimension to infrared spectrochemical imaging technology. The first ever 3D FTIR diatom images were created from a total of 160 FTIR images, captured at 1.5° intervals, from a single goniometer-mounted diatom sample, processed by integration at every angle, and reconstructed to form micron-scale 3D images of component distribution. This allows a never-before-seen view into the cellular distribution of organic and inorganic materials within these important organisms.

References