3D Spectral Imaging of Biological Samples with Synchrotron FTIR Spectro-microtomography

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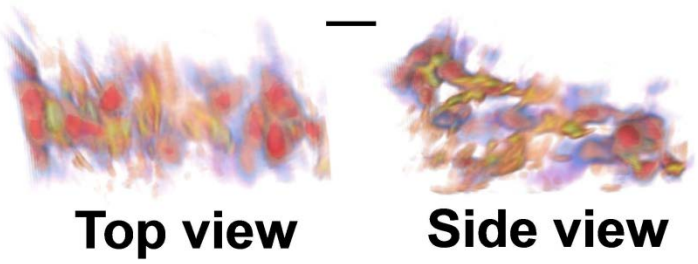
We report Fourier transform infrared spectro-microtomography [1], a three-dimensional imaging approach that provides spectrally rich, label-free, nondestructive visualizations of the distribution of distinctive chemical compositions throughout intact biological or materials samples. The method combines mid-infrared absorption contrast with computed tomographic data acquisition and reconstruction to enhance chemical and morphological localization by determining a complete infrared spectrum for every voxel (millions of spectra determined per sample). We will show results on bio-medical relevant samples such as an intact grouping of pluripotent stem cells where the technique promises a better understanding of the biochemical structure of differentiating stem cells in their microenvironment. We will also show examples of FTIR spectro-microtomography analysis the cell wall molecular architecture in intact plant species important for biofuels. Efficient data collection and analysis facilities with the promise of quantitative analysis are under development which will incorporate advances from protein crystallography, X-ray tomography, medical tomography, FTIR spectroscopy, and supercomputers to automate the collection, reconstruction and storage of large spectral tomographic data sets.



3D protein and lipid distributions for an embryoid body colony of mouse stem cells. Volume renderings from reconstructions for the protein amide I absorption band (1,650 cm^{-1}; blue-red) and lipid bands (2,850 cm^{-1}; orange-yellow) reveal three layers of cell bodies with inhomogeneously distributed lipids. Scale bar, 10 μm.

[1] M.C. Martin *et al*., *Nature Methods* Advance Online Publication, doi:10.1038/nmeth.2596 (2013).