Theoretically predicted, diffraction-limited spatial resolution is demonstrated for the entire mid-infrared spectral range from chemical imaging data collected with a new synchrotron beamline, IRENI [1]. The high brightness of a synchrotron source coupled with a multi-element focal plane array (FPA) detector provides high signal-to-noise data that is spatially oversampled for the entire spectral range. Such results show blurring and fringing effects that are expected from diffraction that are ideal for applying deconvolution, to obtain diffraction-limited spatially resolved images. The point-spread function (PSF) of the imaging system that is required for the deconvolution has been experimentally measured, and theoretically simulated. Since the frequency dependent theoretical PSFs are noise free, they are used to restore images generated from narrow bandwidths (4 cm\(^{-1}\)) over the entire mid-infrared range (4000 – 1000 cm\(^{-1}\)). Several restored images are shown for two metal test samples that are 2.5 microns and smaller, and show improvements as compared to the raw data for frequencies above 2000 cm\(^{-1}\) (see Fig. 1). Importantly, these methods also work for absorbing samples where improved signal to noise spectra are reconstructed from the restored images. Examples of water inclusions in volcanic rocks and prostate cancer tissue at various wavenumbers are shown.

This work is supported by NSF Grant Nos. DMR-0619759, CHE-9984931, and CHE-0832298. The SRC is operated under Grant No. DMR-0537588.

Reference