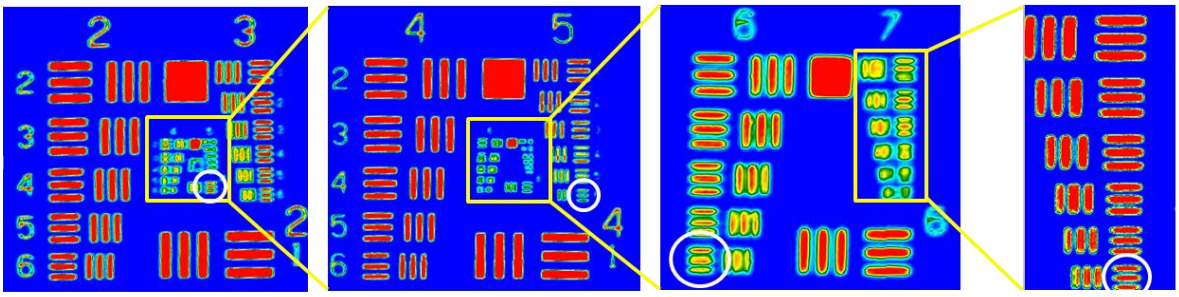
Rapid Large Area Imaging Using FTIR Microscopy

Whether examining multicomponent polymer laminates or conducting a contaminant particle analysis, the ability to timely and accurately image a sample over a given area is critical. Generally, however, most instrument setups are not performing pure imaging; they are typically assembling an image together while collecting data from only one spot at a time. The probe or laser slowly moves in an array over the area to collect spectra as set by a user-defined resolution. A pure imaging system will collect all spectra from a sample area simultaneously, resulting in the collection of potentially thousands of spectra in the same time it would take to acquire a single spectrum.

To illustrate true area imaging, a United States Air Force (USAF) target was imaged at various optical magnifications using a Cary Agilent 670 FTIR microscope. The four images collected are shown in Figure 1. The images were collected using a 32 x 32 focal plane array (FPA) detector. The 32 x 32 FPA indicates that the array is fixed at 32 detectors wide by 32 detectors long. Because the number of detectors cannot change, each pixel in the resulting area scan will represent a different distance at the four magnifications available (4x, 15x, 25x, and 25x high mag). Pixel sizes range from 19 µm using the 4x objective to 0.66 µm using the 25x high mag. objective, and when scanning, each pixel represents one spectrum.

Furthermore, because each pixel can only represent a certain distance, the ability to array or mosaic images together is crucial to create larger images. For instance, the 4x image (Figure 1, left) is an assembly of 64 images collected in an 8x8 array. The final image size is essentially limitless depending on how much time is spent scanning.



4x Standard Magnification	15x Standard Magnification	25x Standard Magnification	25x HighMagnification
Achieved Resolution: 35 um	Achieved Resolution: 8.8um	Achieved Resolution: 5.0 um	Achieved Resolution: 2.2 um
Pixel Size: 19 um	Pixel Size: 5.5 um	Pixel Size: 3.3 um	Pixel Size: 0.66 um
Array Size: 8 x 8	Array Size: 7 x 7	Array Size: 3 x 3	Array Size: 6 x 2
Acquisition Time: 10 min	Acquisition Time: 8 min	Acquisition Time: 3 min	Acquisition Time: 5 min

Figure 1. Four image scans of a USAF target were obtained at different magnifications (4x, 15x, 25x, and 25x high mag) using a Cary Agilent 670 FTIR microscope. The parts of the target used to determine the achieved resolution are circled in white.

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The full scope of the area scanner is even more impressive than it may seem. The FPA collects 1024 spectra in the same time it takes to normally collect a single spectrum. For a standard IR spectra composed of the co-addition of 16 scans, the time saved by the area detector is massive. This is vitally important to imaging areas at high magnifications. For instance, a standard biological cell can range between 25 – 100 μm, and tissue samples are even larger. To do a high-magnification point-by-point scan of these samples would take hours depending on the sample size. However, with the FPA, a typical ~25 μm eukaryotic cell can be imaged at micron resolution in less than 5 minutes.

By virtue of its rapid area analysis, the FTIR is now even better suited to address the needs of even more industries. The pharmaceutical industry (as well as the food/beverage industry) can use it to analyze ingredient distributions and particle analysis. The automotive and forensics world apply it to paint layer and trace evidence analysis. Polymer and plastic laminates are now easily analyzed by a layer-by-layer mosaic across a cross-section of the sample. As discussed, the biochemical world greatly benefits from the enhanced data acquisition rates as cells, tissues, microbes, and other biological samples are very large in size. Combined with its multiple modes of data imaging as well (transmission, reflection, and ATR), the FPA-FTIR system is all but required for chemical imaging needs.