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Extending the Range of MCT Focal Plane Arrays–Based Imaging Systems to Near IR Imaging Applications

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Infrared Spectrochemical Imaging, the technology of coupling a focal-plane array to an FTIR to generate chemical specific images, has become an important tool in many areas of chemical research. The information has allowed researchers to study the chemistries of spatially inhomogeneous samples. Initial development of focal-plane arrays in the mid-IR (2 to 10 μm) was funded by the astronomy community and the U.S. Department of Defense. These researchers defined their devices based on their experiences and frames of reference and on the areas under investigation.

Definitions of IR wavelength ranges differ between chemists and physicists. Defense spending drove the technology toward military technical specifications and applications. These applications included surveillance and sensing to examine relatively “cool” things such as people and land vehicles. The detector material of choice is Mercury Cadmium Telluride (MCT) operating in the photovoltaic mode. Since the wavelengths of interest for the military are in the 2–10 micron range no real interest existed in extending the range of these detectors. The result

is that cameras using focal plane arrays are designed with optical elements in them that limit the response to windows of interest to the physics and remote sensing communities.

Experimental conditions

All data were collected using a Varian Stingray Imaging System equipped with both mid-IR and near-IR optical elements as appropriate for the experiments. Window materials were obtained from the focal plane array camera vendor and mounted following the vendor’s standard procedure.

Results

2-D focal plane arrays are equipped with Germanium (Ge) windows. These windows also typically have an antireflection coating limiting losses from high refractive index materials. The net effect is that these devices will not go to shorter wavelengths than the window material. A single beam spectrum from one pixel of a 64×64 FPA equipped with a Ge window, a mid IR source and KBr beamsplitter is shown in Figure 1A to illustrate

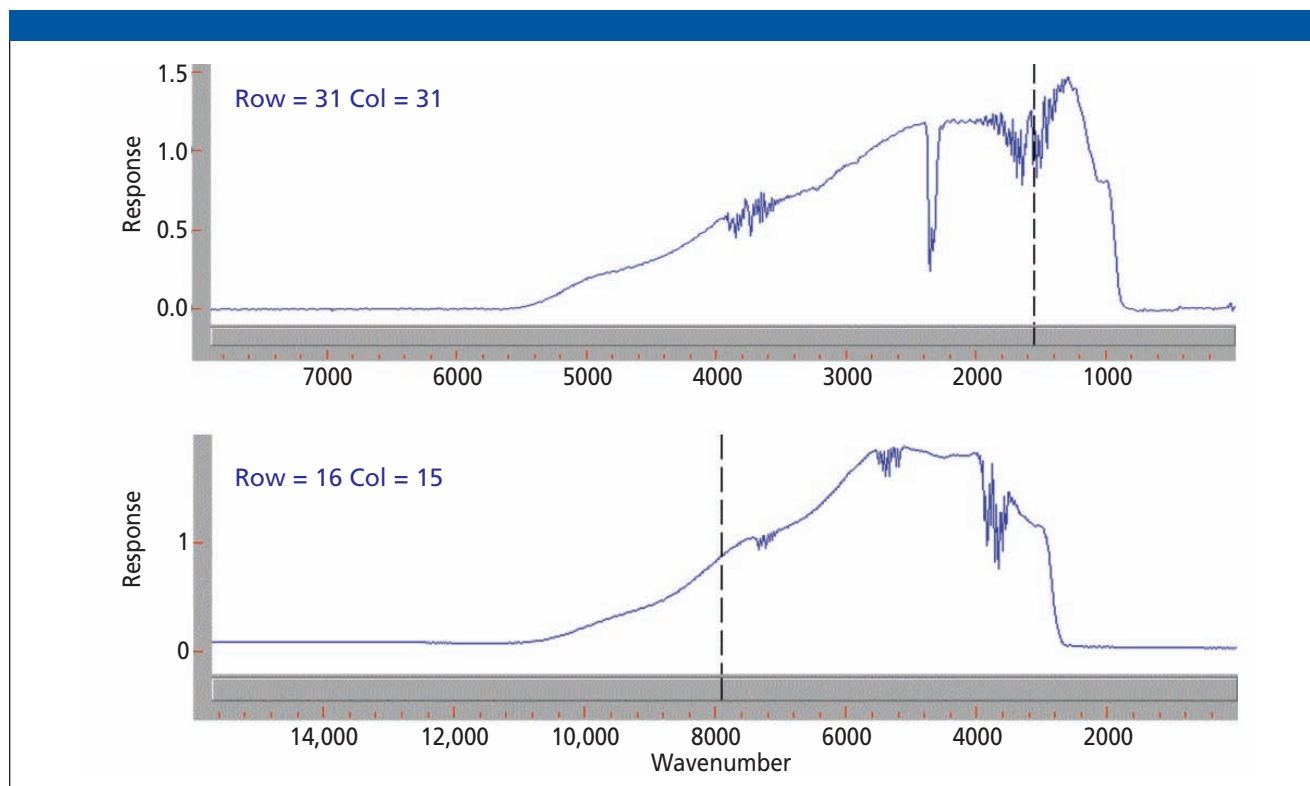


Figure 1: Illustrating the range for the MCT array with the original window (A) and the new window (B).

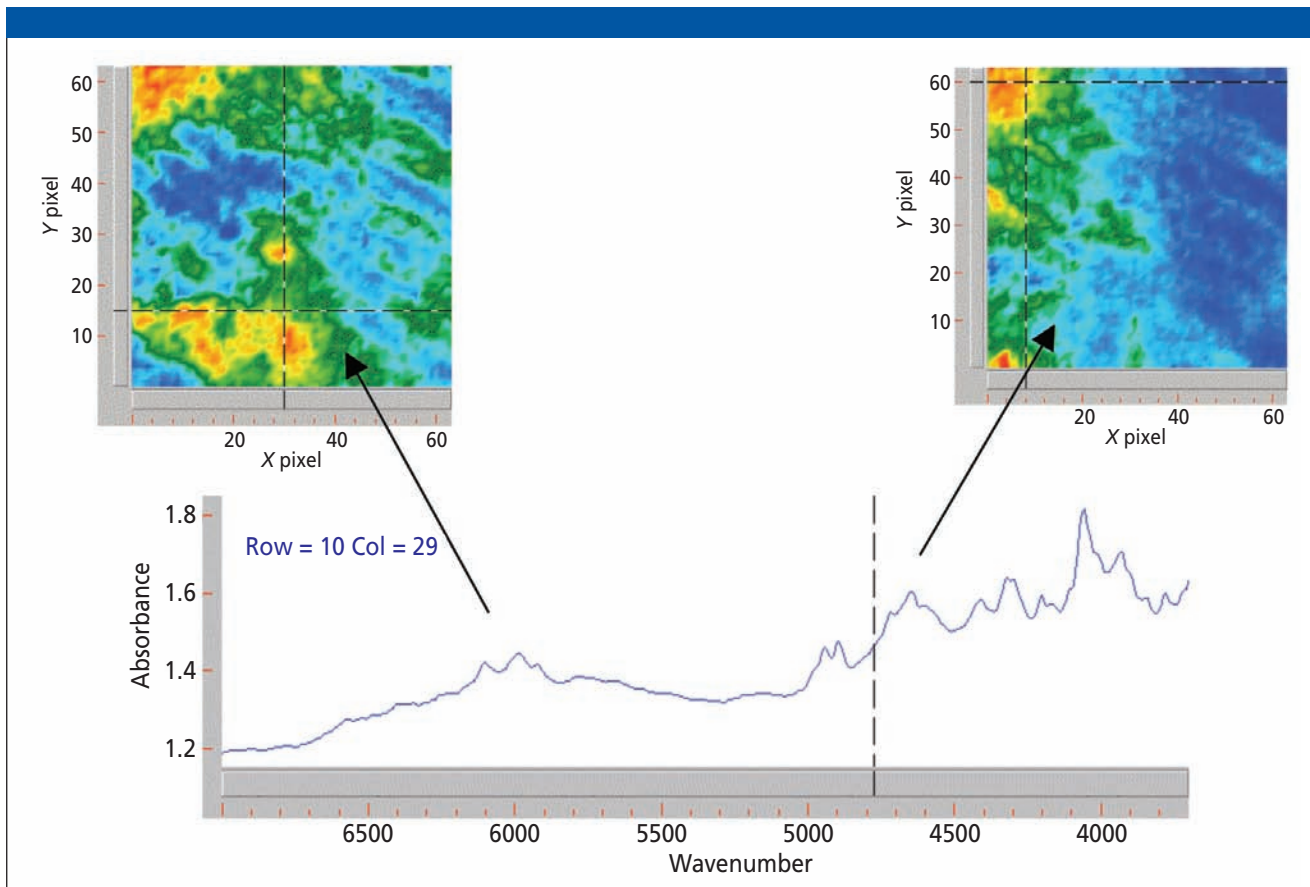


Figure 2: Images and spectra of acetaminophen and pseudoephedrine in a sinus tablet.

the problem. The cutoff is 5500 cm^{-1} on the short wavelength end is due to the window.

MCT is capable of detecting infrared radiation from approximately $1\text{ }\mu\text{m}$ to $25\text{ }\mu\text{m}$ depending on the doping of the material. Most chemical spectroscopists are familiar with using MCT detectors into the near IR although the performance is not optimal. Since the material can detect from 1 to 10 microns, a judicious choice of window increases the usable range.

Replacing the Ge window with a more appropriate material extends the range substantially. With the appropriate instrument optics, we can use the array out to over $10,000\text{ cm}^{-1}$. (Figure 1B).

In a real world application, a tablet of a sinus medication containing acetaminophen and pseudoephedrine was analyzed. The images are shown in Figure 2.

Conclusion

By the appropriate choice of optics on the camera, MCT material can be used over its entire useable range and provide high quality data in the “chemist defined” near infrared.

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