Polymer Laminate Analysis using FTIR Microscopy

Although they may appear to be composed of a singular material, many products in the industrial world are actually layered composites composed of a multitude of materials. Painted surfaces, food and pharmaceutical packages, and medical devices are all often coated sequentially with a variety of polymeric materials. Control over the thickness and uniformity of these coatings is paramount to ensure product quality and function. As such, nondestructive imaging techniques that can examine these coatings are vital to monitoring these variables. With the recent advances in ATR selected area imaging and focal plane array enhancement, FTIR has become a key tool to analyze polymer-based laminates. In this application note, a Cary Agilent 670 FTIR microscope with a 32 x 32 Focal Plane Array (FPA) detector was used to analyze a multi-layered packaging polymer system composed of two major constituents.

First, the plastic packaging was clamped in a microvice assembly. The packaging was then rapidly cut with a razor blade along the surface, resulting in an exposed cross-section (Figure 1, left). This cross-section was then placed under the 15x objective of the microscope and imaged using a germanium ATR crystal (Figure 1, right). Because the size of the FPA is 32 x 32, the maximum ATR imaging window is 35 μm x 35 μm. Yet as can be seen from Figure 2, the plastic is approximately 250 μm in total thickness. As a result, eight total images were collected by moving the stage incrementally 30 μm at a time. The images were then assembled to create an IR overlay (Figure 2, left).

As can be seen from Figure 2, the plastic was composed of six alternating layers of three polymers. The associated FTIR spectra are shown in Figure 2. Interestingly, the plastic optically appeared to be only four layers, but FTIR analysis revealed the presence of six layers. The central layer, although visually only one layer, is actually three distinct layers.

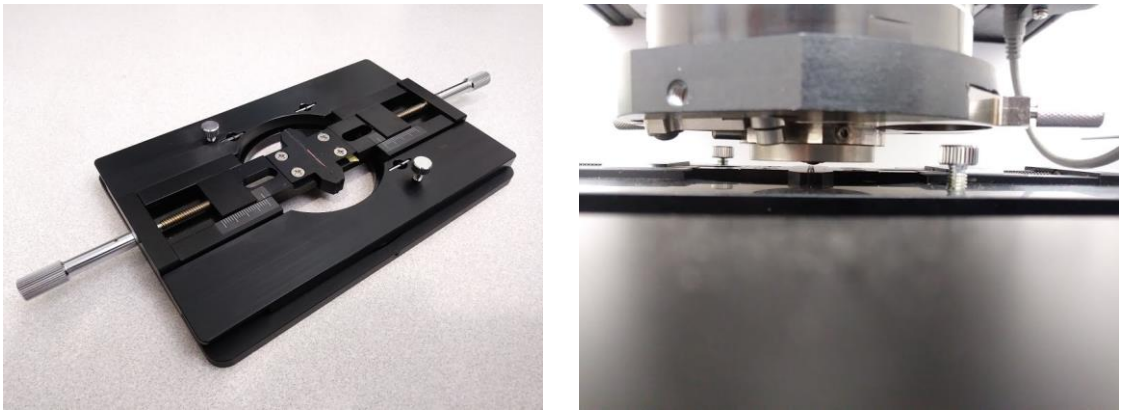

Figure 1. The microvice holder (left) containing a small red sample that has been cross-sectioned and the microvice holder under the germanium ATR microscope accessory (right). (Note: A red sample was chosen for illustrative purposes. It was not the sample that was analyzed.)

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The combination of the FPA detector and selected area imaging makes FTIR a highly valuable analytical tool for any component analysis. Importantly, the imaging detector can acquire tens of thousands of spectra in seconds, and it can be used in ATR, reflection, and transmission modes, allowing for an even greater breadth of applicability.

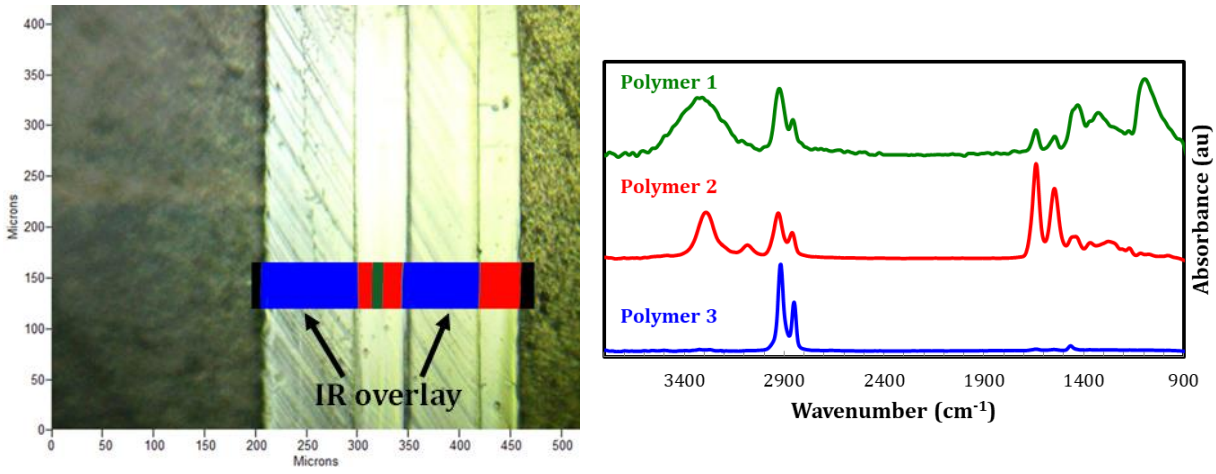

Figure 2. Optical image of a plastic packaging sample with IR image overlay (left) and corresponding FTIR spectra (right).