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Application News

AIMsight™ Infrared Microscope

Multilayer Film Analysis Using the AIMsight Infrared Microscope

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User Benefits

- AIMsight allows the user to view the target area while recording its IR spectrum.
- AIMsight can measure the thickness of thin films in wide-field camera images and microscope camera images.
- A mapping function can be used to create chemical images for visualization of the distribution of constituent materials.

■ Introduction

One of the roles of films in food and pharmaceutical packaging is to maintain product quality. These films often have multiple layers, combining single-layer films to offer a variety of properties such as heat resistance, impact resistance, light shielding, and oxygen barrier properties, depending on the contents of the product.

Determining the material and thickness of each layer in a multilayer film is important for the development of new film materials and quality control. This analysis can also be used for comparisons with competitor products and to study competitor products. Infrared microscopes can be used for qualitative analysis of target areas in the range of 10 to several 100 µm, and thus are suited to the analysis of multilayer films.

The AIMsight infrared microscope comes equipped with a length measurement function and a Spectrum Advisor Function (patent pending). The length measurement function measures the distance between any two user-selected points on images captured by AIMsight (more details below). The Spectrum Advisor Function uses interactive prompts to check for phenomena that could cause errors during measurement, thus allowing users with limited analytical experience to determine if a recorded spectrum is of good or poor quality. More information about the Spectral Advisor function can be found in Application News 01-00456-EN.

This article describes an example of application of the AIMsight length measurement function being used to analyze multilayer films for confectionery packaging.

Fig. 1 IRTracer™-100 and AIMsight™

■ Sample Preparation and Analytical Conditions

Analysis was performed on three multilayer films used to package potato chip products: one product made in Japan (company A) and two products made overseas (companies B and C). Sections of each film were prepared using the microtome (HistoCore AUTOCUT R, Leica Microsystems) shown in Fig. 2. The microtome came with automatic and manual cutting modes and a cutting thickness configurable to between 0.5 and 600 µm. A sample of each multilayer film was embedded in epoxy resin then 20 µm thick sections were prepared and placed on a barium fluoride window for analysis. The analytical conditions used are shown in Table 1.

Fig. 2 HistoCore AUTOCUT R Microtome (Leica Microsystems)

Table 1 Analytical Conditions

Instruments:	IRTracer™-100, AIMsight
Resolution:	8 cm^{-1}
Number of Scans:	45
Apodization Function:	SqrTriangle
Aperture Size:	10 µm × 30 µm
Step Size:	2 µm
Mapping Area:	30 µm × 120 to 154 µm
Detector:	T2SL

■ Wide-Field Camera and Length Measurement Function

AIMsight is equipped with a wide-field camera as standard in addition to its microscope camera, providing a useful and efficient wide field of view of the target object for observation and verification. The wide-field camera has a 10 × 13 mm field of view and a variable digital zoom for up to 5x magnification (2.0 × 2.6 mm). A tiling function can also be used to stitch together images from the microscope camera and create a composite image with a larger image area.

The length measurement function measures the distance between any two user-selected points on not only wide-field camera images and microscope camera images, but also on tile-stitched images (the length measurement function cannot be used on live images). Fig. 4 shows the length measurements performed on each sample. The images show that each company uses a different number and thickness of film layers.

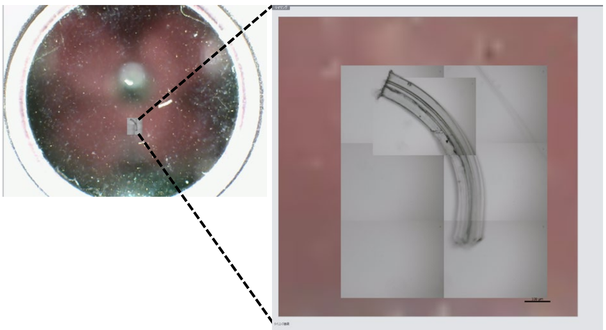
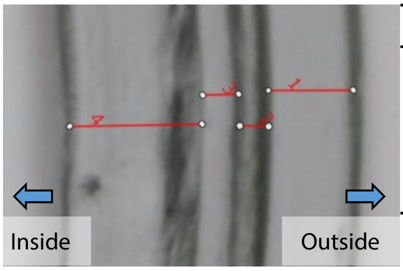


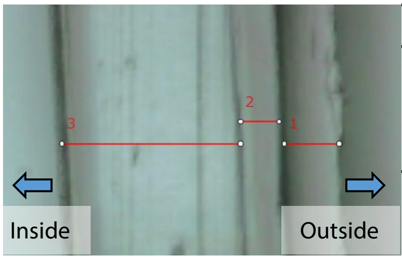
Fig. 2 Wide-Field Camera Image (Left) and Tile-stitched Microscope Camera Image (Right)

Company A (4 layers)



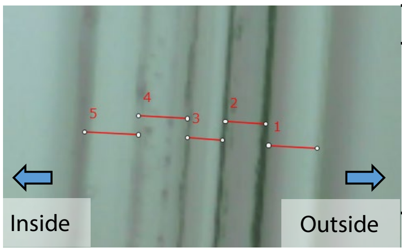
No.	Length (µm)
1	27
2	9
3	11
4	42

Company B (3 layers)



No.	Length (µm)
1	20
2	14
3	65

Company C (5 layers)



No.	Length (µm)
1	18
2	15
3	13
4	18
5	20

Fig. 4 Length Measurements of Each Multilayer Film

■ Chemical Images of Multilayer Films

Figs. 5 to 7 show the transmission spectrum of each layer in each multilayer film (Japanese company A and overseas companies B and C) and chemical images created from mapping measurements. Chemical images can be created from mapping data using peak height, peak area, multivariate analysis (PCR/MCR), or degree of spectral similarity to visualize the distribution of constituent materials not otherwise apparent in visual-field images.

In this example, chemical images were created using the degree of spectral similarity. The greater the degree of spectral similarity, the more intense the color in the chemical image.

The results showed that company A's multilayer film contained four layers, with an outermost first layer of polypropylene (PP), the second layer a mixture of polyethylene terephthalate (PET) and PP, a third layer of PET, and a fourth layer of polyethylene (PE). Note that each mapped area lined up with a layer in the microscope image.

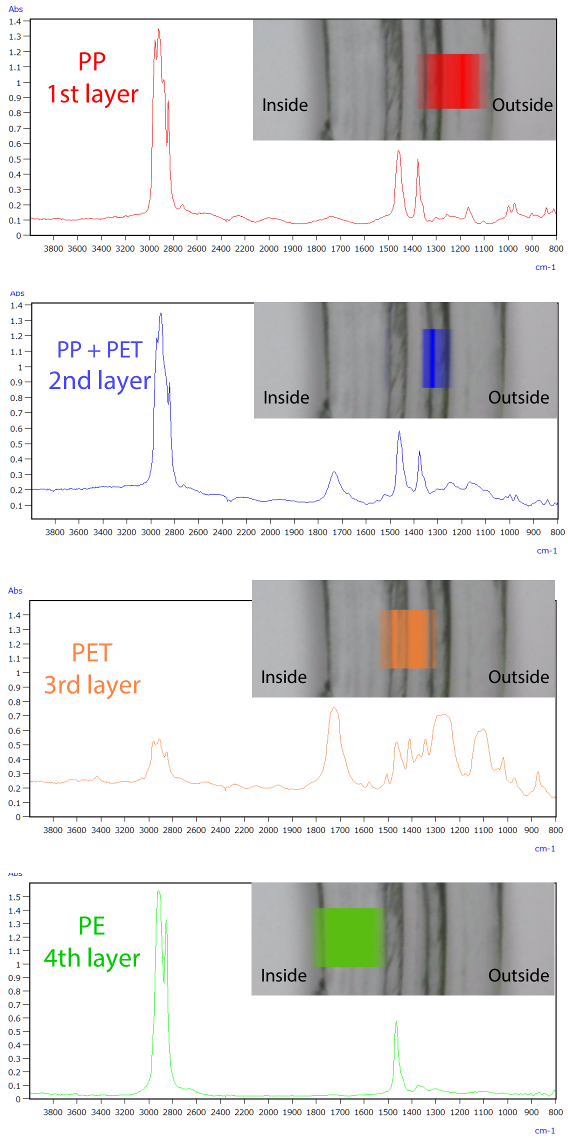


Fig. 5 Transmission Spectrum and Chemical image of Each Layer in Japanese-made (Company A) Multilayer Film

The results show company B's packaging material has three layers, where the outermost first layer is PP, the second layer PET, and the third layer PE. Company C's packaging material has the most layers, where the outermost first layer and the fifth layer are PP, the second and fourth layers are PE, and the third layer is PET. All three packaging materials use PP for the outermost layer, probably because biaxially oriented polypropylene (BOPP) is a good material for printing. All three packaging materials also use an innermost layer of PET, which is probably an aluminum-deposited PET film that provides light shielding and gas barrier properties. Company C also uses PP for the innermost layer of its packaging material and is probably a non-oriented polypropylene (cast polypropylene, CPP) film. CPP film is often used for the innermost layer of packaging material due to its heat-sealing properties and excellent abrasion resistance.

Although the three companies used similar materials in their multilayer films, the thickness and order of the layers differed between the companies.

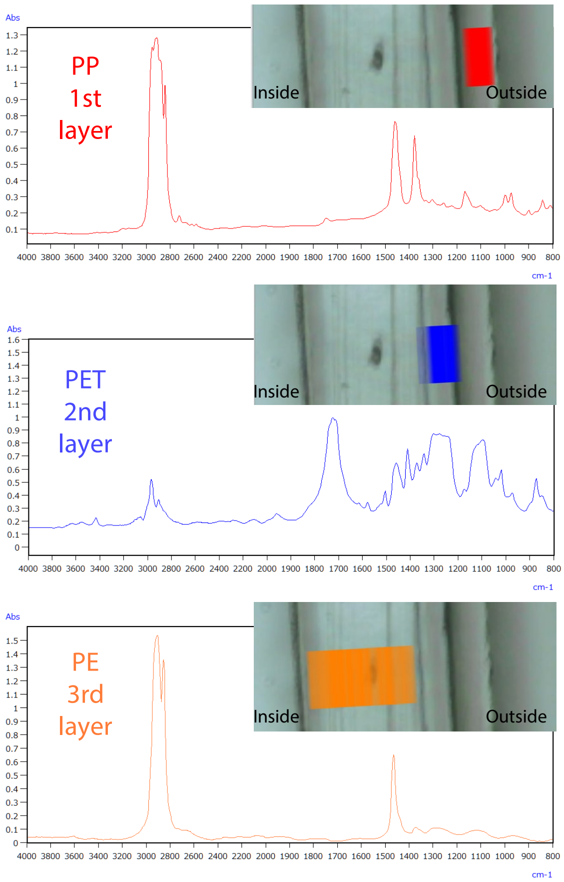


Fig. 6 Transmission Spectrum and Chemical Image of Each Layer in Overseas (Company B) Multilayer Film

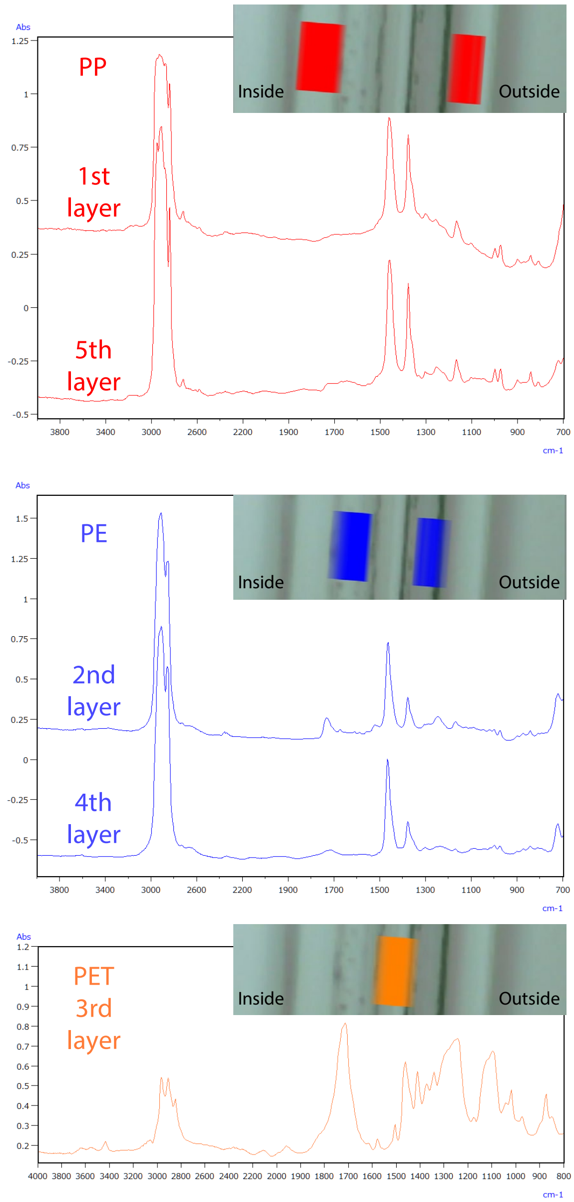


Fig. 7 Transmission Spectrum and Chemical Image of Each Layer in Overseas (Company C) Multilayer Film

■ Conclusion

This article presents an analysis of three multilayer films from different manufacturers.

The length measurement function of AIMsight can be used to determine the thickness and size of samples from wide-field camera images, microscope camera images, and tile-stitched images. Visible-field images were superimposed with chemical images created from mapping data to reveal the distribution of constituent materials in individual layers, an analysis that is useful for the development and quality control of multilayer films.

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