

Polyethylene terephthalate film surface and infrared attenuated total reflection spectroscopy

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Introduction

Infrared spectroscopy allows two types of analysis processes. One is the transmission and the other one is the attenuated total reflection (ATR). ATR process is frequently used for solid samples because of their multiple types of shapes. In fact, a beam of light hits a crystal or a prism and the sample next to it at an angle bigger than the critical one. The results are sent to a detector and red into a spectrum band.

This method was used to analyze polyethylene terephthalate (PET) film surface. There are two important points to check out about PET film surface analysis: the crystal type and the reflection mode.

This article explains in the first place the crystal choice, and then the advantages of reflection mode. To conclude we will determine the conditions that better fit to PET surface analysis.

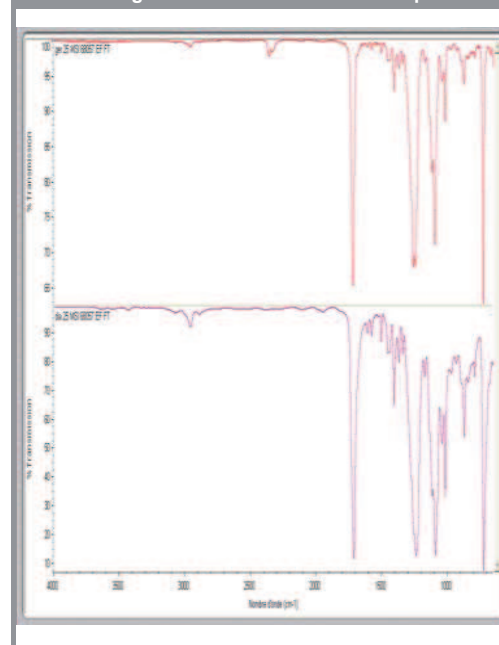
Experimental discussion

Our samples were sheets of polymer with multiple coating types on. So in order to analyze only the coating thin line we needed the radiation to stay on surface. A type of crystal is chosen for its refractive index also known as optical index. If the index is high, the radiation enters only into a few micrometers of the sample. The more the index value rises the more the beam stays on the surface. That is explained by Snell-Descartes refractive equation: $n_1 \sin r = n_2 \sin i$. n_1 and n_2 are indices of two different optical environments. i is the angle of incidence and r the angle of refraction of the beam through the sample. That equation means $\sin r = (n_2/n_1) \sin i$. The higher $\sin r$ is, the better it is for surface analysis because the refractive angle r is wider, so the radiation stays on the surface. To have a great $\sin r$ knowing that the incidence angle i is fixed by the spectroscope, we have to change the value of the quotient (n_2/n_1) . If n_2 is bigger than n_1 , the quotient value is higher, so are $\sin r$ and r . Knowing those facts, we can surely conclude that, it is better to use a crystal or a prism with a big optical index to analyze PET surface.

There are different types of reflections: mono reflection and multiple reflections also called multiple internal reflections.

To use mono reflection with solid samples, a weight down had to be applied on the sample. That was to improve the contact between the crystal and the sample. According to my results cf. figure 1 that method was not so efficient. The advantage of using internally reflected radiation was to increase even more the contact between the crystal and the sample and make the absorbance of the ATR spectra band grow. The result was an average of the multiple measurements that included more precision and more details on the spectrum. Therefore, multiple internal reflections will be a good choice to analyze PET film surface.

Germanium ATR spectra with mono reflection : red
Diamond ATR spectra with mono reflection: pink
Not a big difference between the two spectra.



Conclusion

Finally we can conclude that multiple internal reflections with high optical index prism or crystal (n superior to 4) are the better conditions to analyze polymer film surface.

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