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HUMAN HEALTH | ENVIRONMENTAL HEALTH

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Fresh

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E D I T O R I A L

We at PerkinElmer believe when say that things need to be 'Fresh' all the time. It's the only way we can distinguish ourselves from the rest.

With that in mind, we have decided to tailor-make your 'Fresh' experience to meet your requirements and interest.

Those of you in the Chemical and Polymer background will greatly be interested in this month's Fresh. In this brief and crisp edition, we bring to you a study on Polymer Crystallinity using the RamanStation 400F.

We then taken it down a notch and introduce to you a revolutionary concept in bank notes – the Polymer Bank Note, designed and developed in Australia over 20 years ago, and very soon to be introduced in India.

WHAT'S Fresh inside...

Introduction

Today's advanced and increasingly diverse polymer laboratories are facing new challenges on a daily basis – starting from the roots of the raw materials right up to the finished product. Our comprehensive portfolio of analytical solutions is designed to give you the higher accuracy, sensitivity and ease of use your laboratory demands for examining with confidence the purity, composition and performance of your plastics and polymers.

What's more, a range of complementary services is available to keep your laboratory up and running, meeting the stringent requirements of a variety of environments and working practices.Better insights for better products. Choose PerkinElmer

A Study of Polymer Crystallinity
Using the RamanStation 400F

Industrial Application

It has been shown that, using the RamanStation 400F spectrometer, a rapid assessment of crystallinity in fabricated PET bottles can be achieved, quickly and easily. This has obvious applications in the design of mold tools for PET products as well as on-line QC monitoring in production environments.

Introduction

The study of polymer crystallinity is important as the degree of crystallinity is directly related to the ruggedness and impact resistance of many polymers. A good example of this is Polyethylene Terepthalate or PET. PET is commonly used in beverage containers, particularly those used for carbonated soft drinks. These containers are produced in very large quantities.

A better understanding and increased control of the crystallization process could result in thinner bottles that retain the same strength. A reduction in the amount of polymer feedstock used could not only provide a large economic benefit, but could also potentially reduce environmental impact.

PET beverage containers are stretch blow molded from an amorphous plastic plug. The expanding polymer comes in contact with a cold metal mold and rapidly takes its final form. This process can result in strain-induced crystallinity. As the polymer is nonuniformly stretched during the process, different regions of the PET container have varying crystallinity.

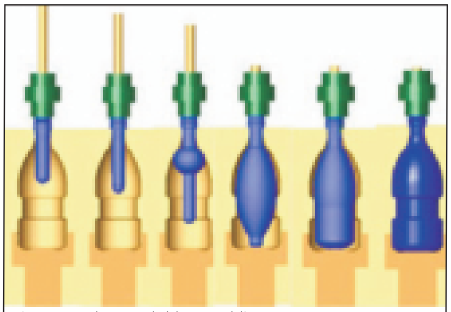

Figure 1 : The strech blow molding process

Raman Analysis of PET Bottles

Figure 2 shows the fingerprint region of Raman spectra taken from three places on a PET bottle using a PerkinElmer® RamanStation™ 400F. No sample preparation was necessary and no pieces of the bottle were removed for this analysis.

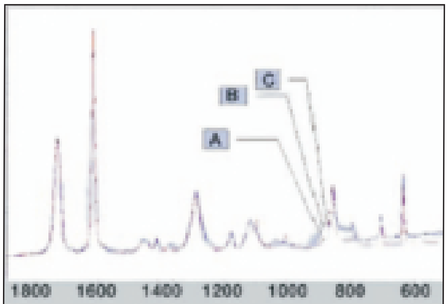

Figure 2: Raman spectra from top (B). middle (A) and (C) of PET bottle

It has been reported that the crystalline content of semi-crystalline PET can be determined from Raman spectra in at least two ways. The first of these is the peak ratio of bands at approximately 1,120 cm-1 and 1,100 cm-1 Raman shift.

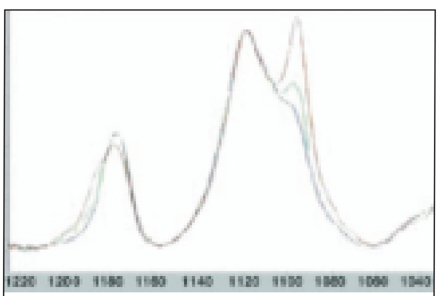

Figure 3: Details of the Raman spectra in the 1,060-1,220 cm^{-1} region

Figure 3 shows the details of the Raman spectra in the region of interest (1,060 cm-1 to 1,220 cm-1 Raman shift). The spectra indicate a range of degrees of crystallinity. Highly crystalline samples exhibit a large peak at 1,095 cm-1; whereas amorphous samples simply show a shoulder on the 1,120 cm-1 peak.

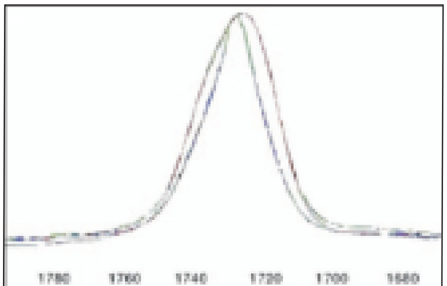

Figure 4: Raman bands at 1,730 cm^{-1}

The second technique involves consideration of the peak width of the Raman emission at 1,730 cm-1. This is shown in Figure 4. Again, the spectra result from a range of samples with varying degrees of crystallinity. The highly crystalline samples give a narrow peak; whereas the amorphous bandwidth is demonstrably broader.

In the next study, the peak ratio technique was used to compare the crystallinity of a PET bottle along its length.

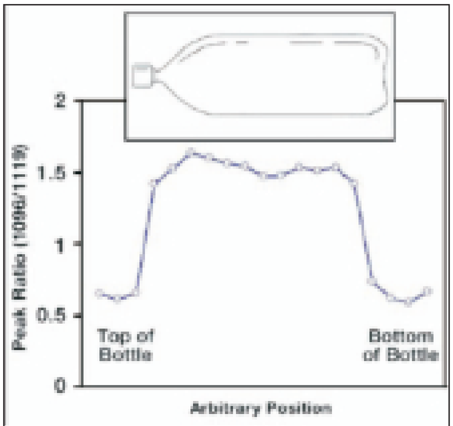

Figure 5: Variation of Raman peak ratio associated with crystallinity along the length of a PET bottle

The graph in Figure 5 illustrates the variation in the ratio of Raman peaks at 1,096 cm-1 and 1,119 cm-1 showing a large change in crystallinity along the length of the bottle. The data shows the material is essentially amorphous in the threaded top portion and the bottom of the bottle, whereas it is relatively crystalline in the rest of the bottle. Moreover, the degree of crystallinity is quite constant over the length of the bottle except for two transition regions near the top and the bottom, where there is a rapid increase in crystallinity.

The world's first Polymer Banknote

The CSIRO **(Commonwealth Scientific and Industrial Research Organisation (CSIRO))** helped develop the world's first polymer banknote, creating the most secure currency in the world.

For hundreds of years, banknotes have been made from rag-based paper. Today, banknote issuers are faced with the challenge of increasingly sophisticated counterfeiting techniques and there are serious doubts that paper remains a viable material for secure banknotes.

With this in mind CSIRO and Note Printing Australia Limited, a subsidiary of the Reserve Bank of Australia, set out to improve the security and durability of Australia's currency.

What CSIRO did

CSIRO's expertise in polymer and synthetic chemistry was used to develop a non-fibrous and non-porous plastic film, which the banknotes are printed on. This substrate gives high tear initiation resistance, good fold characteristics and a longer lifetime than paper.

The substrate and the specially-developed protective overcoat prevent the absorption of moisture, sweat and grime so that the polymer banknotes stay cleaner.

CSIRO has also developed a variety of overt and covert security features for use on polymer banknotes. These security features are produced from a combination of spectroscopic techniques, synthetic chemistry, nanotechnology, surface science microstructure manipulation and polymer chemistry.

First circulated in Australia in 1988, polymer banknotes are now used in 22 countries.

The outcomes

The result is the world's first non-fibrous polymer banknote. As well as being more secure, the banknote is four times more durable than rag paper notes.

Polymer banknotes are also in use overseas either as commemorative or circulating notes.

Currently there are over thirty different denominations totalling some 3 billion polymer notes in service in 22 countries worldwide.

In addition, a press-ready polymer substrate (Guardian™) is available for countries with their own note printing facilities.

Guardian™ is produced by Securency Pty Ltd, a joint venture between the Reserve Bank of Australia and Innovia Films PLC, a European-based manufacturer of polypropylene films.

'Irrespective of your industry, counterfeiters are the fiercest competitors a business will ever face,' says Dr. Gerry Wilson of CSIRO Molecular and Health Technologies Division. 'The challenge is to keep one or more steps ahead of them.'

Having dramatically slashed the rate of counterfeiting in Australia, CSIRO is using the skills and networks gained during the development of the polymer banknote in the fight against identity theft and counterfeit pharmaceuticals.

Contact Us

Training Calendar

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