

## Tracing the Source of Illicit Drugs Through Plastic Packaging—A Database

**REFERENCE:** Roux C, Bull S, Goulding J, Lennard C. Tracing the source of illicit drugs through plastic packaging—a database. *J Forensic Sci* 2000;45(1):99–114.

**ABSTRACT:** Common plastic drug packaging material available in Australia and in Asia was analyzed using a standard protocol including optical examination, UV-visible and Fourier transform infrared spectrometry. The aims were to determine whether there are significant differences between different sources, to establish the evidential value of these examinations, and to build a database of common packaging material.

Visual examination was the most effective means for discriminating samples. Thickness and weight measurements provided useful information. Visualization of machining marks using crossed polarized light was found to be useful in the comparison process. UV-visible spectrophotometry has some value for distinguishing samples. Fourier transform infrared analysis was a good technique for determination of the polymer composition of the packaging. Significant differences were observed between Australian and overseas samples.

The “Australian Database of Drug Packaging Materials” was created to systematically collate all of the collected data for application on personal computers. It is concluded that the properties of plastic packaging materials can be excellent indicators for identifying the specific brand or origin of the packaging.

**KEYWORDS:** forensic science, substance abuse detection, drug packaging, plastic materials, polymer, illicit drugs

One possible method to help trace the source of illicit drugs is to examine the packaging used to contain the drugs. Unfortunately, this part of illicit drug evidence is often overlooked. It is important to expand this way of thinking to encompass the whole concept of drug intelligence, including a thorough examination of both the drugs and the packaging material. Where the packaging has been considered in the past, it has often led investigators to the source of the drugs and to the perpetrators.

There is an extremely wide variety of materials used every day for packaging and smuggling illicit drugs. In fact, drugs can and have been packaged in almost anything—from linings of suitcases to pineapple tins to condoms and plastic bags. For the purpose of this research, the Australian and New Zealand forensic science laboratories were surveyed and it was found that plastic products make up five of the six most common products used for drug pack-

aging. These results prompted the emphasis of this research on plastic packaging materials and confirmed their potential importance in identifying the provenance of illicit drugs.

The requirement for this research was further supported by the fact that the Discriminating Power (DP) of some techniques for the analysis of plastic packaging materials had not been fully investigated. In addition, based on the outcome of earlier studies (1–3), it is clear that the plastic packagings used for illicit drugs consist of just a small number of generic types, and it is uncommon for a single test to uniquely identify a sample of plastic packaging with its manufacturing batch or plant or geographical location, or to associate one sample with (or distinguish it from) another. To build a conclusive view of the provenance of a sample of plastic drug packaging that will stand up as evidence in a court of law, it will generally be necessary to compare a range of physical and chemical properties of the sample with those of similar plastics of known origin. It is in such circumstances that a broadly based data collection finds valuable application. No such database, relevant to the plastic packaging materials commonly associated with seizures of illicit drugs in Australia, has previously been compiled.

The specific aims of this study were to analyze common plastic drug packaging materials available in Australia and Asia using an analytical sequence including optical and morphological examination, UV-vis spectrometry and FT-IR to: (a) determine whether there were differences between Australian and Asian samples, (b) build a database to help trace the source of the drugs, and (c) investigate the evidential value of the proposed examinations.

### *Plastic Packaging Material and Analysis*

Plastics, or polymers, are a byproduct of the petroleum industry, and the principal raw materials are organic chemicals used as monomers and plasticizers, and speciality chemicals that are used as additives to modify the properties of the plastic produced (4). Co-polymerization, which involves linking together two or more polymers, is sometimes carried out as an alternative method to using additives, for changing the properties of the plastic.

The polymers most commonly used in plastic packaging are polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), and polyethylene terephthalate (PET). The variety of polymers and chemical additives used means that there is the possibility of linking drug packaging samples together through their chemical fingerprint.

The chemical techniques that have been tested in the past for the examination of plastic drug packaging materials include infrared spectroscopy (2,3,5,6), thermal desorption capillary gas chromatography (2), X-ray fluorescence spectroscopy (6,7), thin layer chromatography (3), microspectrophotometry (3), and neutron activation analysis (6).

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Received 29 Jan. 1999; and in revised form 26 March 1999; accepted 5 April 1999.

In addition, physical characteristics can be used to match plastic packaging, which has been used to contain drugs, to packaging found in a suspect's possession, or more broadly, to show that the packaging comes from a certain batch, or brand. These identifying characteristics can take several forms, including marks due to the manufacture (1,8–11) or impurities (9) and printing defects (1).

The combination of these physical features along with the color, printing, dimensions, thickness, and the arrangement and type of sealing, cut edges, and perforations (construction characteristics), allow plastic bags or sections of plastic film to be compared and conclusions to be drawn about their origin or relationship to each other.

In regard to the physical properties, a number of methods have already been described for visualizing the characteristic marks mentioned above. Physical methods used include a simple photographic method (8,11), a visualization method whereby a grid of alternating black and white lines (an interference grid) is illuminated behind a sample (12,13), Magna Jet Black fingerprint powder (10), transmitted light with low power magnification and a "profilometer" used to measure calliper average, low point, high point, and profile (9), a polarization table (1,13) followed by the use of an optical bench for both shadowgraph and Schlieren imaging (1,13), and incident and transmitted light microscopy (1).

## Materials and Methods

### Sampling

Australian samples were obtained by visiting all of the major supermarket chains in the Sydney region: Woolworths, Franklins, Coles, and Jewel. Each different size and type of plastic bag or wrap was purchased, with the exception of shopping (tidy) bags and garbage bags as these are not in common use as illegal drug packaging.

For comparison purposes, samples from the Asian market were obtained by Australian Federal Police liaison officers from Hong Kong, Bangkok, Singapore, and Jakarta.

The final 77 samples consisted of 46 samples from Australia and 31 samples from Asia. As the samples were obtained, the following information was noted and recorded: type of product, brand, batch number/bar code, size given on package, and date of purchase. The break down of Australian and Asian samples is given in Table 1.

### General Optical Examination

An initial visual examination was carried out for each sample. During this examination, the plastic bag or film was observed by

the naked eye, using artificial light. A general description of the packaging material was written, including features such as subjective color, and the type of plastic (shiny/dull, textured/smooth). At this stage, the construction of the bags was observed and recorded, including the number and position of seams, folds, cuts, perforations, and seals. The presence of any labels or printing, and a description of these, was also noted. The dimensions of the packaging materials were then measured using a ruler.

General appearance of packaging materials was recorded using a Pentax K1000 single lens reflex camera with ISO 100 film and artificial light. Minor detailed features such as labels, printing and the sealing mechanism were photographed using a zoom lens. Photographs of small details such as printing defects, small portions of labels, and printing, machining marks, seals, and the characteristic pitted texture of some bags were taken using a Leica MZ6 stereomicroscope (6 to 40× magnification).

### Thickness Measurement

The thickness of each packaging material was measured using a Mitutoyo micrometer, with a precision of  $\pm 0.002$  mm. All thickness measurements were of a single sheet of plastic. Three measurements were taken for each sample, and these were then averaged to reach a final thickness.

### Weight Measurement

Each of the samples (excluding the cling wrap samples) was then weighed on a standard analytical balance. Measurements were carried out for two bags of each sample type, to evaluate weight consistency within a batch. These two measurements were then averaged to give a final weight measurement.

### Examination Under an Intense and Filtered Light Source

A Polilight PL10 multi-wavelength light source (Rofin, Australia) was used to illuminate each of the packaging materials and to help observe any characteristic features, such as luminescence. The sample to be observed was placed on a black background, and viewed under strong white light. The Polilight was slowly scanned from 350 to 650 nm, and any observations were noted. This process was repeated numerous times, while viewing through a range of interference filters (350 to 650 nm band-pass filters).

### Observation of Machining Marks Using Crossed-Polarized Light

The packaging material was placed between two polarizing filters aligned in crossed-polar orientation. In the crossed-polar orientation, the light passing through one polarizing filter is blocked by the second filter. When the packaging material is placed between the filters with an orientation of 45°, it will transmit light in a pattern that reveals the processing history of the material.

Machining marks and birefringence colors were noted by viewing the plastic packaging through a pair of crossed polarizing filters, held directly above a lightbox. Observations were recorded and a photograph of each sample was taken using a Pentax K1000 single lens reflex camera. The photograph was taken in the dark, from directly above the set-up, using only the transmitted light from the light box. Where specific characteristics of interest were observed, a close-up photograph was taken using the zoom lens.

Small Glad Snap-lock Bags and Large Glad Snap-lock Bags from two separate batches were also compared by this method.

TABLE 1—Samples analyzed in this study.

Product	Australian Samples	Asian Samples
Cling wrap	9	6
Snap-lock bags	5	10
Freezer bags	18	1
Sandwich bags	6	3
Oven bags	4	—
Food storage bags	2	2
Long life vegetable bags	2	—
Re-sealable bags	—	1
General plastic bags	—	8
Total	46	31

### UV-Visible (UV-Vis) Spectrophotometric Analysis

UV-visible spectra were recorded on a Cary 3E UV-Vis double-beam spectrophotometer. A  $3.0 \times 3.0$  cm piece of the plastic packaging was simply placed in a sample holder, in the path of one of the beams of the spectrophotometer. The background sample holder, in the path of the second beam, was left empty. The spectrophotometer was set in absorbance mode with both UV and visible lamps operating. A signal averaging time of 0.100 s, and a scan rate of 10 nm/s was used for each sample.

Repeated experiments determined that, for colorless samples, it was only useful to scan from 190 to 350 nm, while for colored samples, it was necessary to scan from 190 to 800 nm.

Each sample measurement was duplicated, to determine any variability within the technique. Also, two samples from different bags/pieces of film of the same brand and type of packaging material (from the same packet/roll) were analyzed by this method, to evaluate within-batch variability.

### Fourier Transform Infrared (FT-IR) Analysis

Fourier transform infrared spectra of each sample were recorded on a Nicolet Magna-IR 760 spectrometer using the Nic-plan Infrared microscope attachment. The microscope was used in reflectance mode, through the use of a zinc-selenide (Zn-Se) attenuated total reflection (ATR) objective, with a liquid nitrogen cooled MCT-A (mercury cadmium telluride) detector. The number of scans was set at 256, with a resolution of 4. The beamsplitter used was an XT-KBr beamsplitter. No ATR correction was used.

Each sample was scanned between 4000 and  $650 \text{ cm}^{-1}$  with an aperture setting of 32. A background spectrum was run before each sample measurement. Once a sample spectrum was recorded, the reference library was searched to determine the polymer type.

### Database

The "Australian Database of Drug Packaging Materials" was created to systematically collate all of the collected data for application on personal computers. The database contains 77 records and was created using Claris File Maker Pro 3.0 software for Microsoft Windows 95. Both the UV-visible spectra and the FT-IR spectra were converted from their respective software into Microsoft Excel '97 charts, and were then imported into the database. Similarly, photographs were scanned into Kodak Photoworks software, and then imported into the database.

### Blind Tests

Five separate blind tests were carried out using the techniques developed for the database. The aim of the blind trials was to determine, as far as possible, the identity of the plastic packaging, by carrying out tests using the database. Broad fields were used to narrow the search possibilities, and then specific information used for comparison with the remaining samples.

## Results and Discussion

### Discriminating Powers

The discriminating power (DP) (14) for a number of the techniques used in the "Australian Database of Drug Packaging Materials" was determined by calculating:

$$DP = \frac{\text{Number of discriminated pair}}{\text{Number of possible pairs}}$$

TABLE 2—Discriminating powers obtained for each technique applied to the samples described in Table 1.

Technique	Discriminating Power (DP)	Percentage Discriminated (%)
Thickness Measurement	0.72	72
Crossed Polarized Light Technique	Close to 1	Close to 100
UV-Vis Spectrophotometry	0.83	83
FT-IR Analysis	0.77	77

The discriminating powers for thickness measurement, visualization of machining marks using crossed polarizing filters, UV-vis spectrophotometry, and FT-IR analysis, are given in Table 2.

### General Visual Examination

The initial optical examination was found to be an excellent method for discriminating different samples of plastic packaging. By taking into account the color, arrangement of construction characteristics, the method of sealing, and the presence of any printing or labels, it is often possible to narrow considerably the candidate materials. Differences were observed between Australian and Asian samples during this step.

It was found that all clingwrap samples purchased in Australia had a width of approximately 33 cm, except for the Glad Microwave Wrap (width ~30 cm). The Glad Microwave Wrap is manufactured in Japan. All samples originating from Asia had a width of approximately 30 cm. The textured pattern, or lack thereof, on some sandwich bags proved to be a good feature for discriminating between samples of this packaging type. A comparison of the different patterns on two sandwich bags, observed through a low powered stereomicroscope is given in Fig. 1.

### Thickness Measurement

Thickness measurement was found to be a useful technique for this application, with 72% of samples being discriminated by this method (see Table 2). The advantage of this technique is its simplicity and inexpensive nature.

### Weight Measurement

Weight measurement also provided some important information, although it was not possible to carry out this step for some large samples, due to the limitation of analytical equipment available.

The weight measurements of two different samples from the same batch, for each of the 77 samples, varied by 0.05 g at the most.

### Examination Under an Intense and Filtered Light Source

It was determined, after the analysis of each sample by this technique, that optical examination under the Polilight light source was not useful in discriminating the colorless (transparent) samples of plastic packaging. In the few instances where faint luminescence was observed, it was observed across the range of samples of the same packaging type and therefore did not distinguish them. The same result was observed with the limited number of colored and printed samples which were obtained, therefore the technique provided no additional information in these cases. For the above rea-

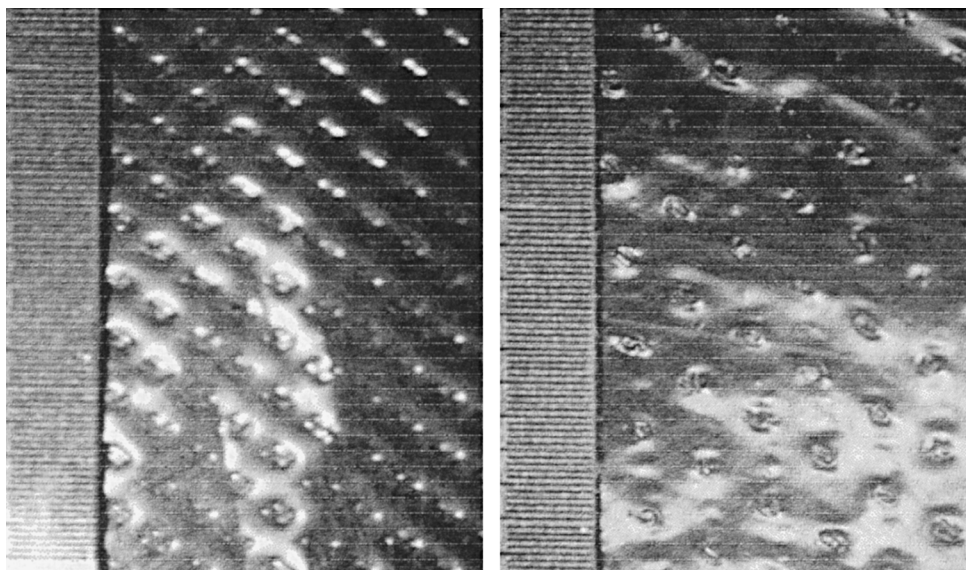


FIG. 1—Different surface patterns on “Pretty Polly” sandwich bags (left) from Hong Kong and “Savings” sandwich bags (right) from Australia.

sons, the technique was left out of the database. However, optical examination under the Polilight may still have application for some samples, especially when these are colored.

#### *Observation of Machining Marks Using Crossed-Polarized Light*

Observation of machining marks, including those which indicate direction of manufacture, using polarized light was found to be an excellent technique for discriminating samples of plastic packaging, with the discrimination of samples being close to 100% (see Table 2).

It would be interesting to study multiple samples of one or all of the products over a longer period of time. The reason for this is that the appearance of a certain brand of product, when viewed with crossed-polarized filters, will be different if the company starts using a different machine to manufacture the product, or even as resin material builds up and wears away on the die, rollers and other parts of the same machine. Unless this information is available, and constantly updated, these factors impose a limitation on the crossed-polarized light technique in a database situation.

Although this technique is limited in a database situation, it is extremely useful in specific comparisons. For example, in a case where a large drug seizure has been made, and on searching a suspect's house or vehicle some plastic bags or film are found, it is possible to compare the plastic packaging by viewing through crossed-polarized light. This can either show that the plastic packaging has completely different machining marks, and is unrelated, or that the packaging has similar machining marks and has been manufactured on the same machinery at around the same time, or that the packaging was joined together during manufacturing, before cutting into bags or smaller lengths of film, and is therefore most probably from the same packet after manufacture.

However, it is important to be careful when making conclusions in this manner. All of the bags in one packet may not be in sequence. Also, during quality control procedures at the manufacturing plant, some bags may be removed from the packet for testing and replaced with bags from another packet or batch.

Therefore, if a plastic bag discovered in a suspect's possession is found to match a bag containing illicit drugs, it can be said that the

bags were manufactured on the same machinery at around the same time, or in some cases, that the bags were directly connected during manufacture, and were therefore from the same packet of bags. However, if the plastic bag discovered in a suspect's possession does not match the plastic bag containing illicit drugs, it cannot be said that the bags definitely did not come from the same packet.

It was found, that in some cases, when a sample was examined between crossed-polarized filters, characteristic markings were observed which directly linked the sample to a certain brand or product. Glad Wrap (GLAD) is a good example of this. When viewed using crossed-polarized light, Glad Wrap is observed to have characteristic diamond shaped or cross-hatched roller marks (Fig. 2).

Some differences in birefringence colors were observed between the two different batches of both the Small Snap-lock Bags (GLAD) and the Large Snap-lock Bags (GLAD) when examined with crossed-polarized light.

#### *UV-Visible (UV-Vis) Spectrophotometric Analysis*

UV-vis spectrophotometric analysis was found to be a worthwhile technique for use in the database. This is reflected in the high percentage (83%) of samples in the database being discriminated by this technique (Table 2).

The UV-vis spectra of two different samples from the same batch, for each of the 77 samples, showed no variation.

The UV-vis spectra could be broken into five main groups based on the general shape of the spectra and positions of peaks. There was, in general, no clear relationship between these groupings and the packaging type or other obvious property of the packaging. The UV-vis spectra of these five main groups are included in Fig. 3.

The UV-vis spectra could be broken into a further four small groups. The oven bags (Samples 39–42/Group 6) exhibited absorbance that was off scale at all measured wavelengths, hence, no usable spectra were obtained. It is possible that this result is due to the fact that they are all manufactured from the polymer polyethylene terephthalate. This allowed these samples to be discriminated from other samples. The sample of Glad Microwave Wrap (Sample 2/Group 7) exhibited an exponential shaped spectrum, with no peaks or other features. This result may reflect the

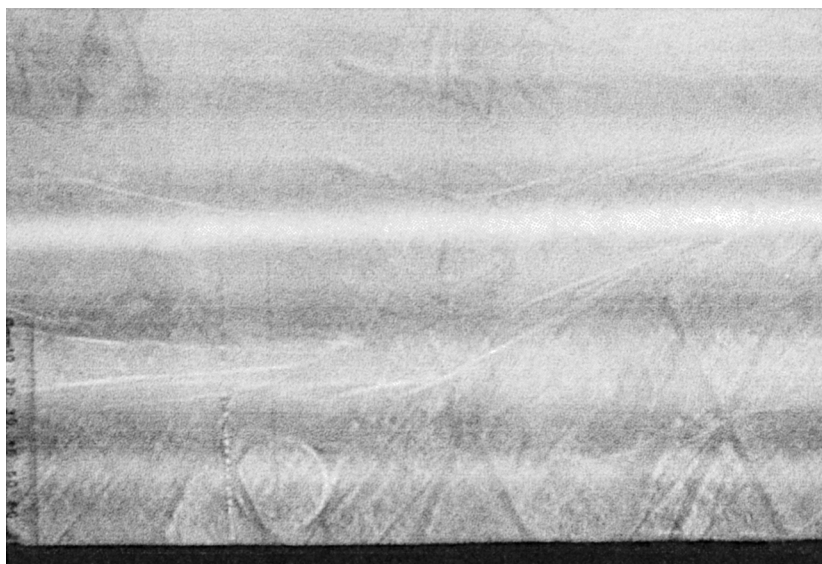
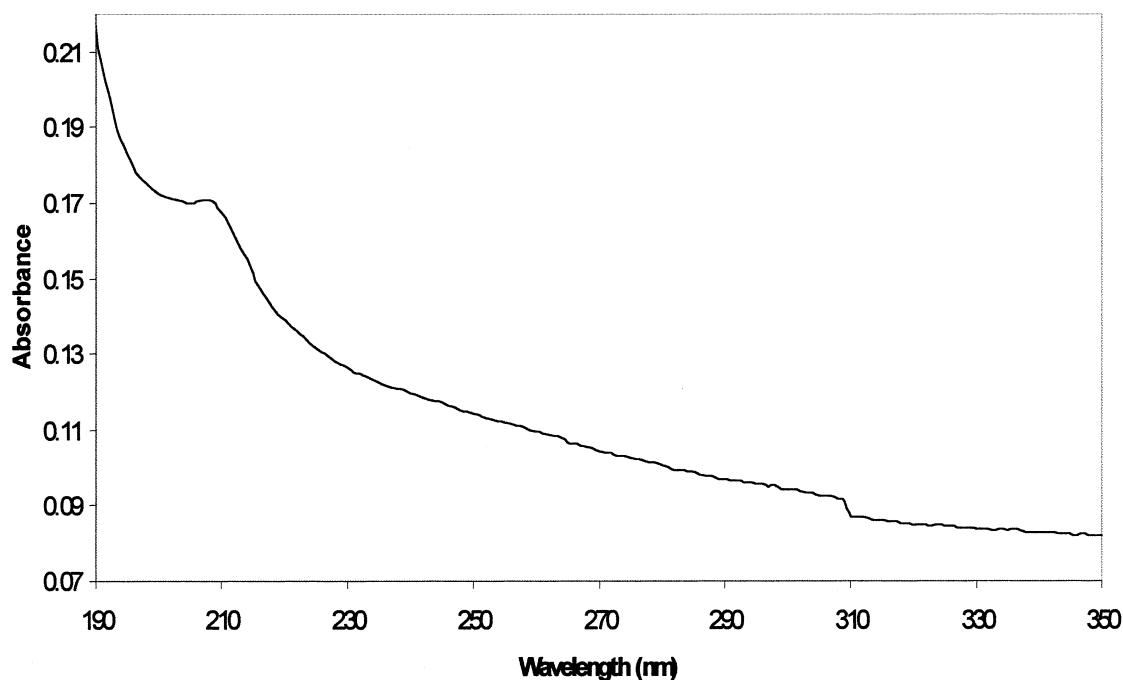


FIG. 2—Appearance of characteristic cross-hatched roller marks on Glad Wrap (GLAD), when viewed through crossed polarizing filters.



A

FIG. 3—UV-Visible spectra of: (a) Group 1, (b) Group 2, (c) Group 3, (d) Group 4, and (e) Group 5.

fact that it was the only sample made from the polymer polyvinylidene chloride. This allows it to be differentiated from all other samples. The two samples of Robs’ Long Life Vegetable Storage Bags (Samples 43–44/Group 8) are green in color and therefore exhibit features in the visible region of the spectrum, which allow them to be differentiated from all other samples. The Apotic Chemist snaplock bag (Sample 59/Group 9) is blue in color and therefore also exhibits features in the visible region of the spectrum. It can be differentiated from all other samples. Peaks present in the spectra of each UV-vis group are indicated in Table 3.

TABLE 3—Groups discriminated by UV-visible spectrometry.

UV-Visible Group	Peaks Present in Spectrum (nm)
1	210, 310
2	205, 250
3	230
4	190, 230
5	195, 230
6	N/A
7	None
8	390, 640
9	230, 260, 350, 610, 720

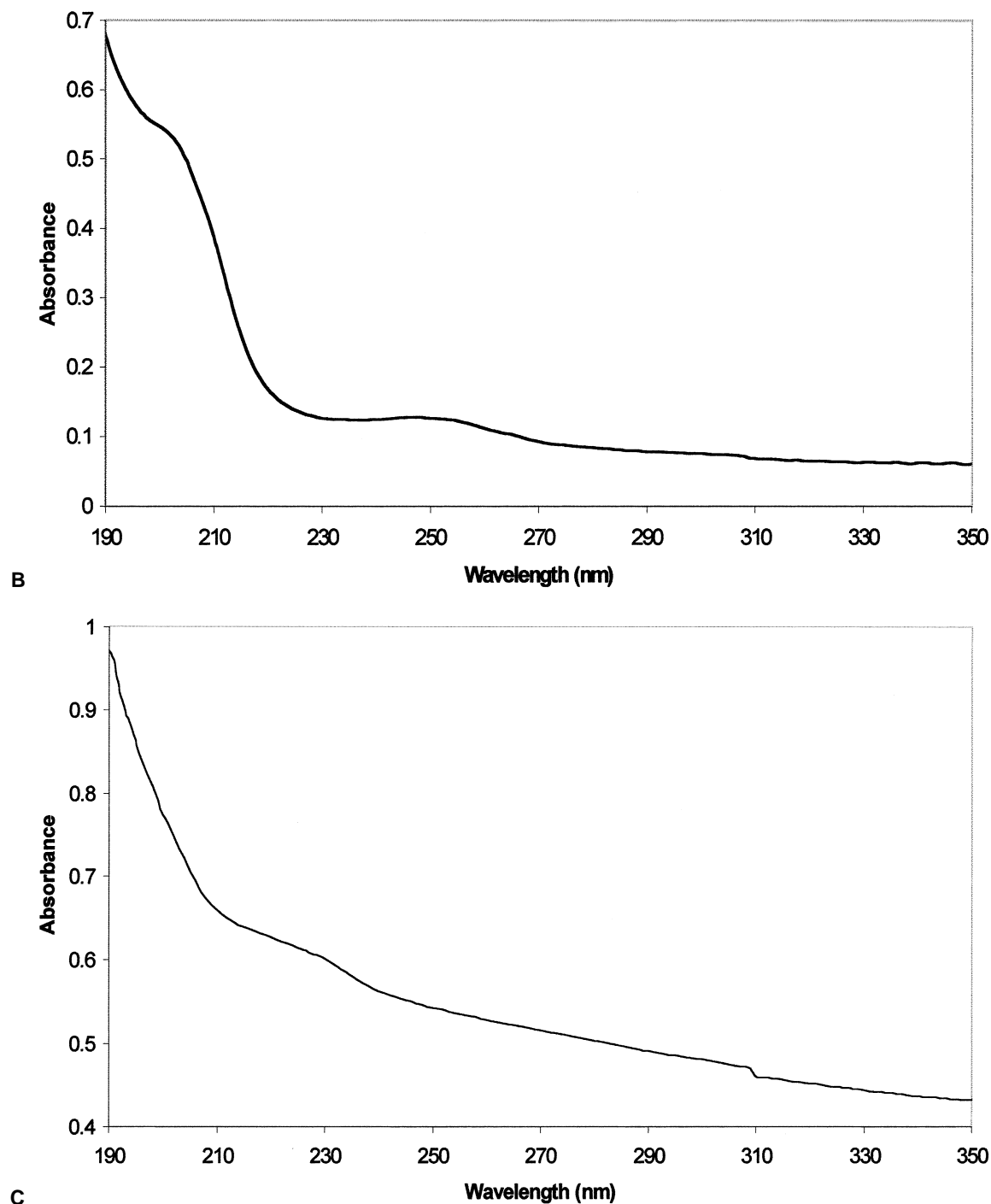


FIG. 3—(Continued).

#### Fourier Transform Infrared (FT-IR) Analysis

The FT-IR analysis was found to be a good initial test to determine the base polymer from which the packaging was manufactured. Even in the case of polyethylene, accounting for 80% of the samples, it was possible to distinguish three different groups.

FT-IR analysis also has implications for discriminating Australian and Asian samples. Out of the 15 samples which had a base polymer other than polyethylene, ten of these were Asian samples.

In other words, only five of the 46 Australian samples were not made from polyethylene. This included four oven bags manufactured from polyethylene terephthalate, and one microwave-safe clingwrap sample made from polyvinylidene chloride (this product is actually manufactured in Japan). With the exception of oven bags, the conclusion that can be drawn is that a sample having a base polymer other than polyethylene is an indication of a foreign origin.

The advantage of using FT-IR reflectance microscopy is that it is a non-destructive technique and only a tiny amount of sample is

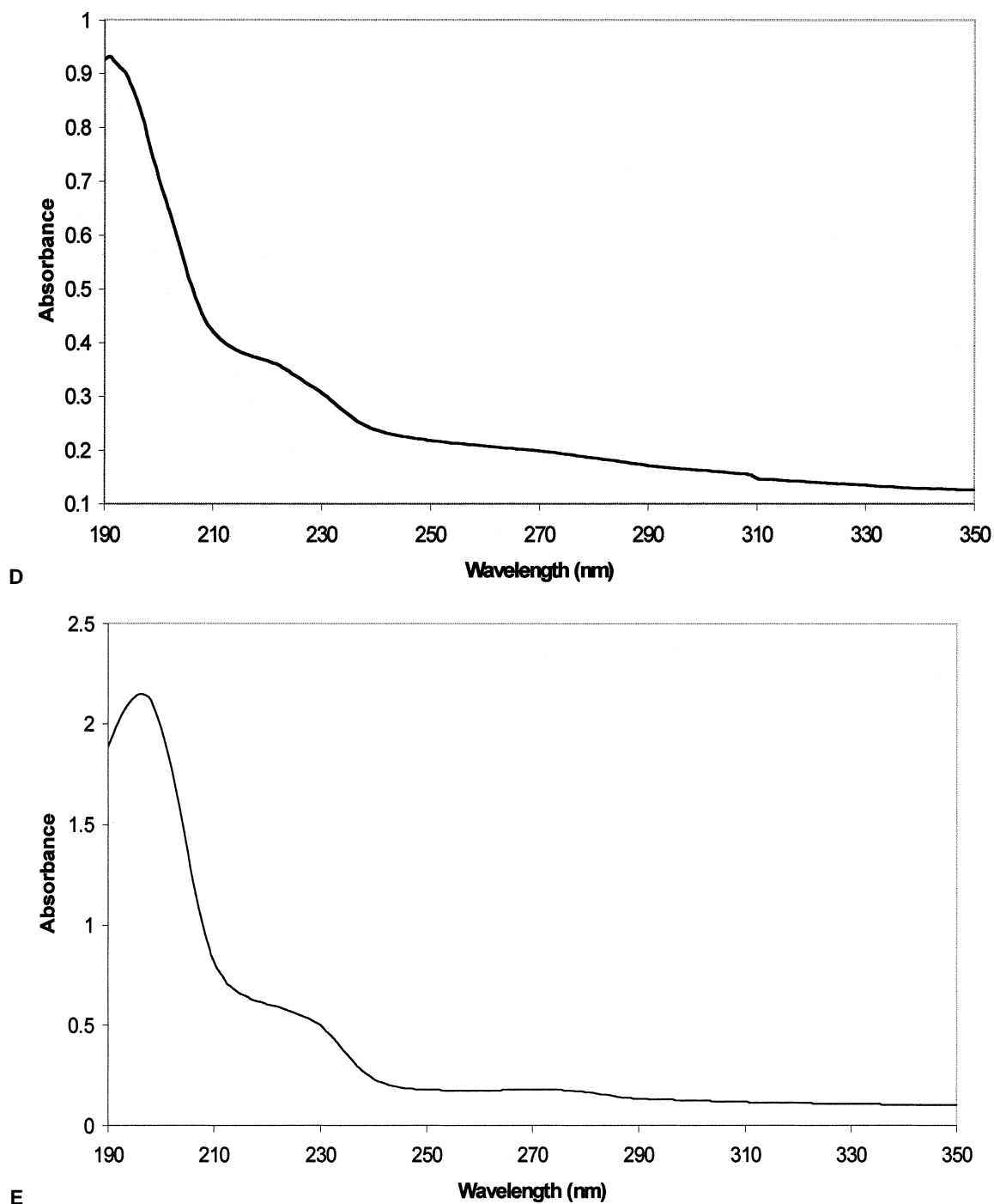


FIG. 3—(Continued).

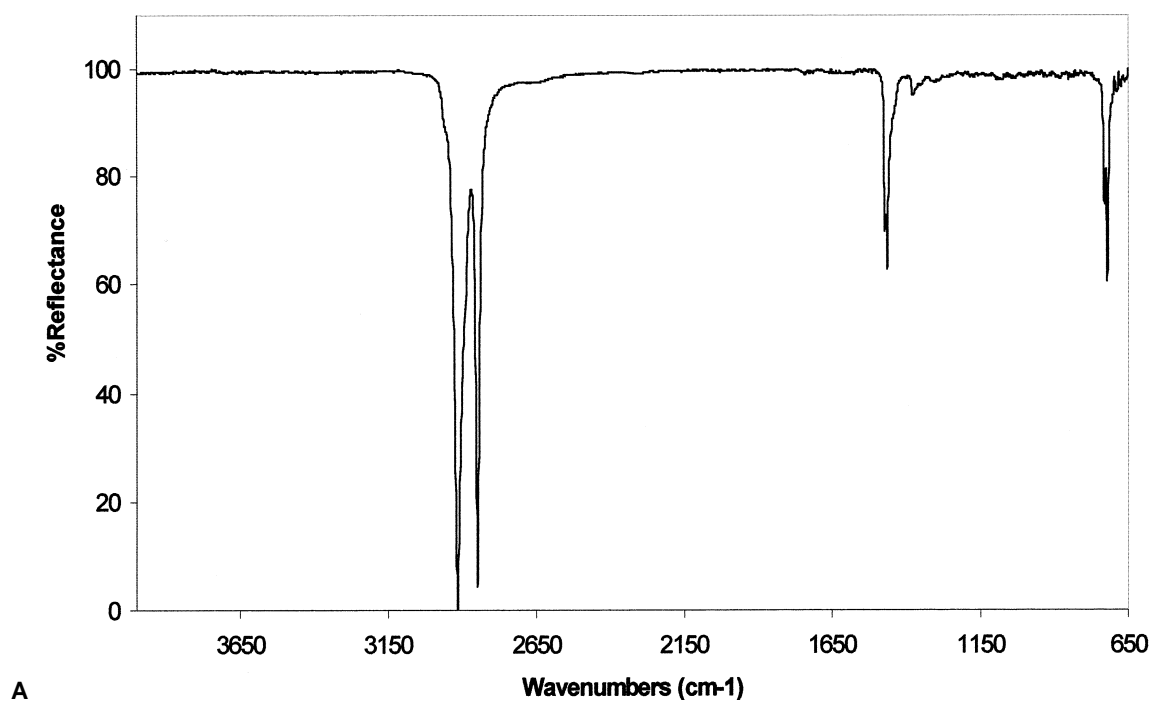
necessary (although in drug crimes there are usually large amounts of packaging). The technique requires no sample preparation, with a single sheet of the plastic sample being placed in contact with the ATR objective for spectral data to be collected.

The FT-IR spectra of two different samples from the same batch, for each of the 77 samples, showed no significant variation.

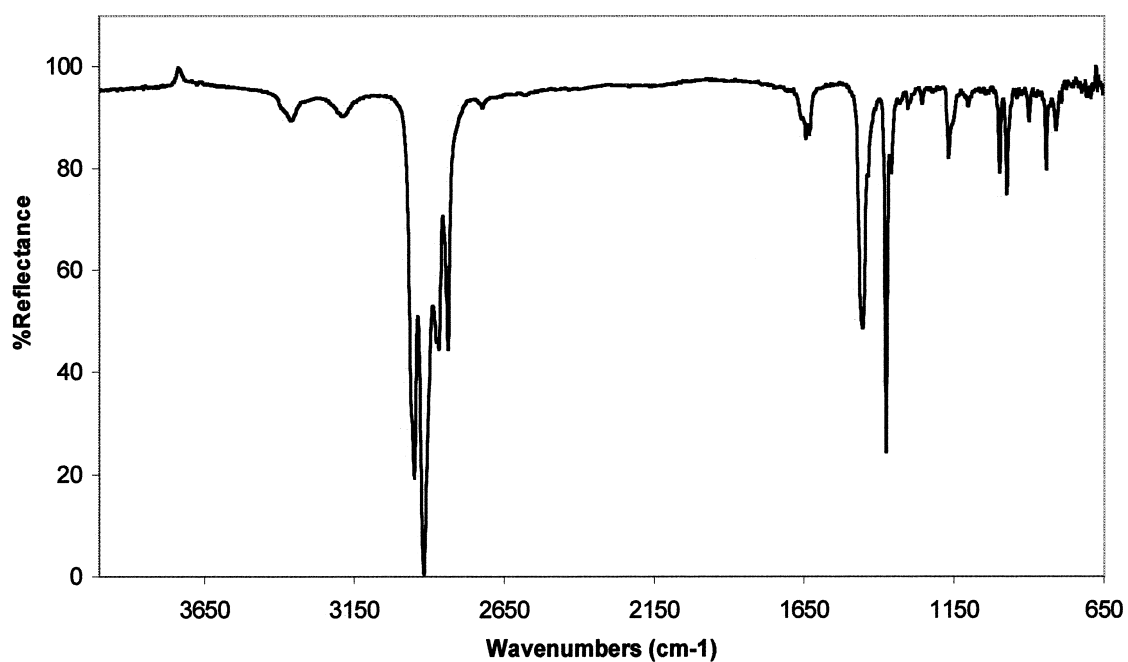
The FT-IR spectra could be broken into five main groups which equated to their polymer type. The five polymer types were: polyethylene (Group A), polypropylene (Group B), polyvinyl chloride (Group C), polyvinylidene chloride (Group D), and polyethy-

lene terephthalate (Group E). Spectra for each polymer type are included in Fig. 4.

The spectra for the polymer type polyethylene could be further broken into three sub-groups. Some of the polyethylene packaging materials show a peak in their FT-IR spectrum at approximately  $1740\text{ cm}^{-1}$ . This peak is most likely due to the ester  $\text{—C=O}$  group of a polyvinyl acetate co-polymer present in some quantity, as consistent with Ref 1,8 and 9. This specific grouping of polymers is called ethylene/vinyl acetate or EVA (Group F). The samples which contain this peak can be discriminated from other polyethy-



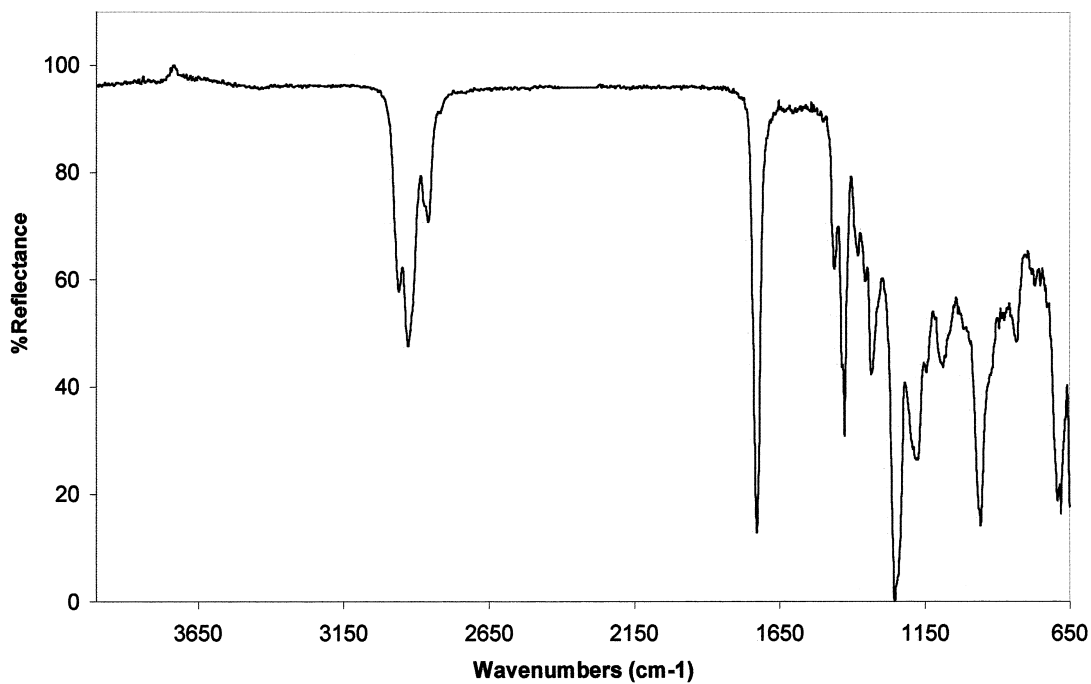
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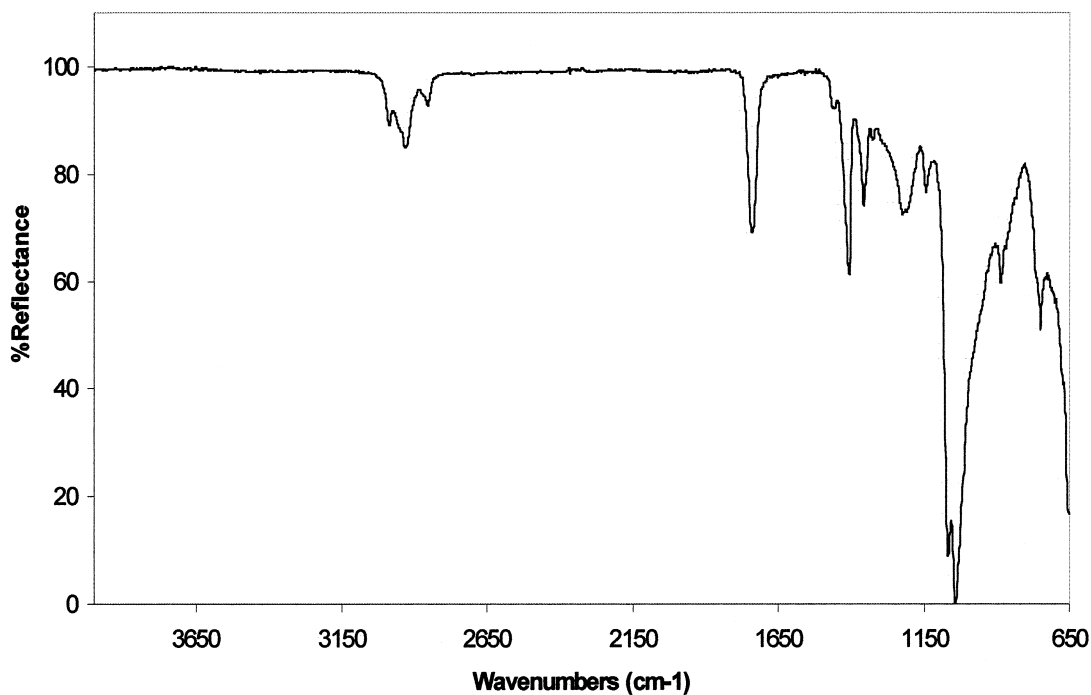
B

FIG. 4—FT-IR Spectra of: (a) Polyethylene (Group A), (b) Polypropylene (Group B), (c) Polyvinyl chloride (Group C), (d) Polyvinylidene Chloride (Group D), (e) Polyethylene terephthalate (Group E), (f) Polyethylene with vinyl acetate co-polymer peak at  $\sim 1740\text{ cm}^{-1}$  (Group F), and (g) polyethylene sub-group with peaks at  $\sim 1740\text{ cm}^{-1}$  and  $\sim 1250\text{ cm}^{-1}$  (Group G).





C



D

FIG. 4—(Continued).

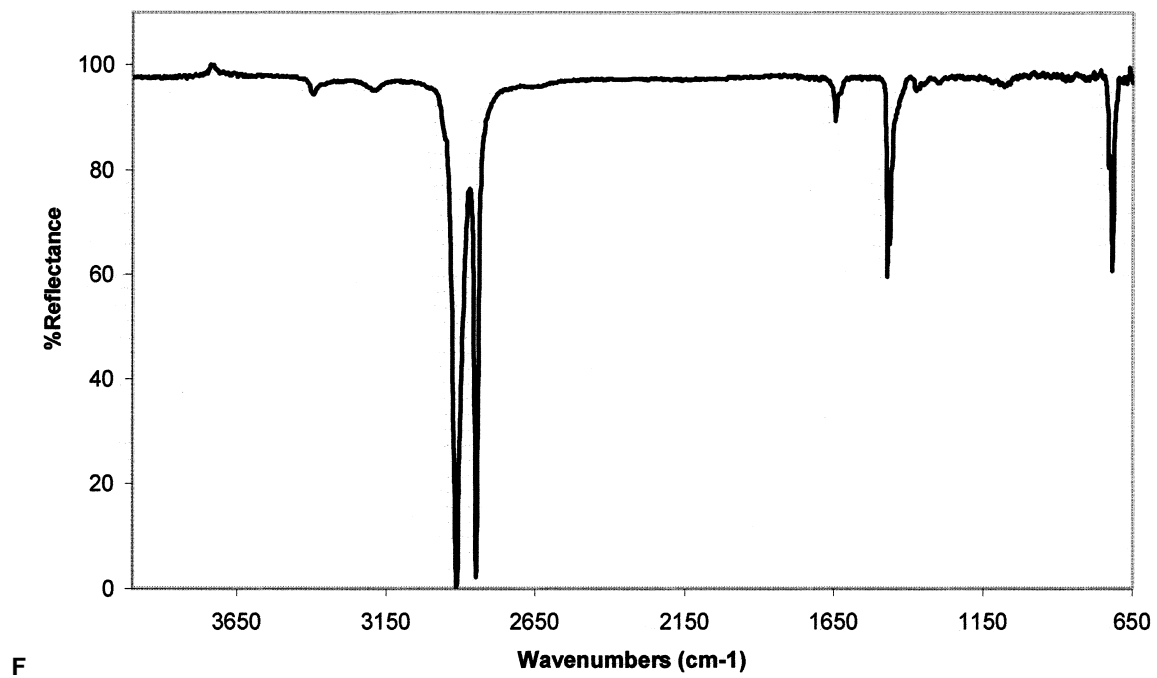
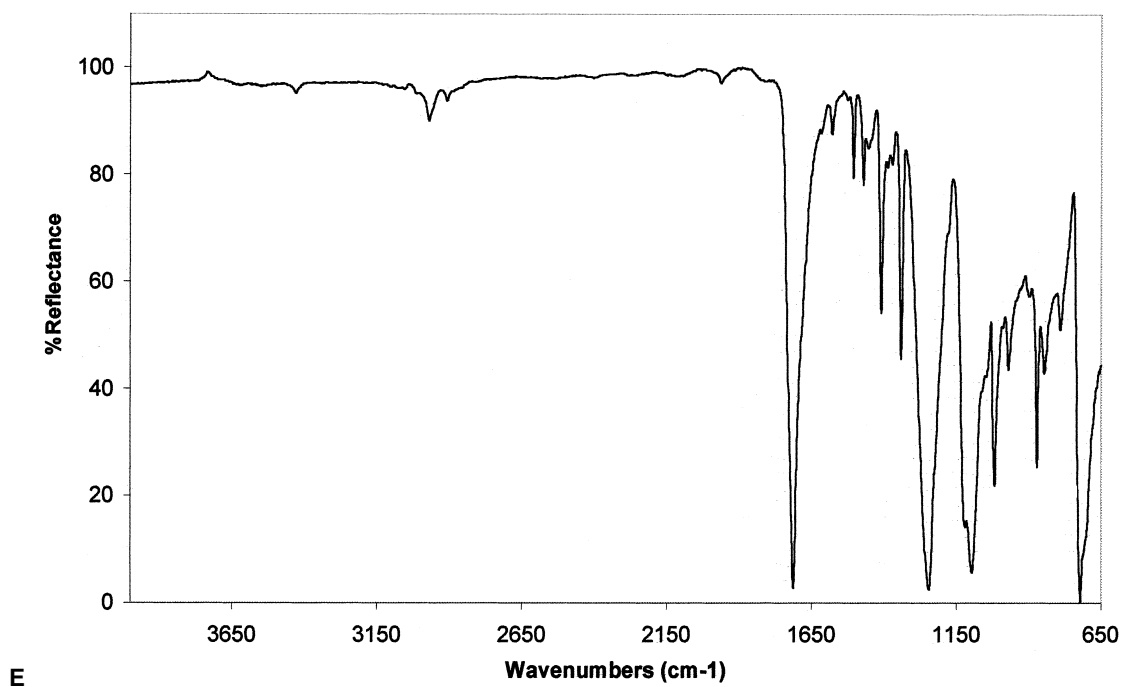


FIG. 4—(Continued).

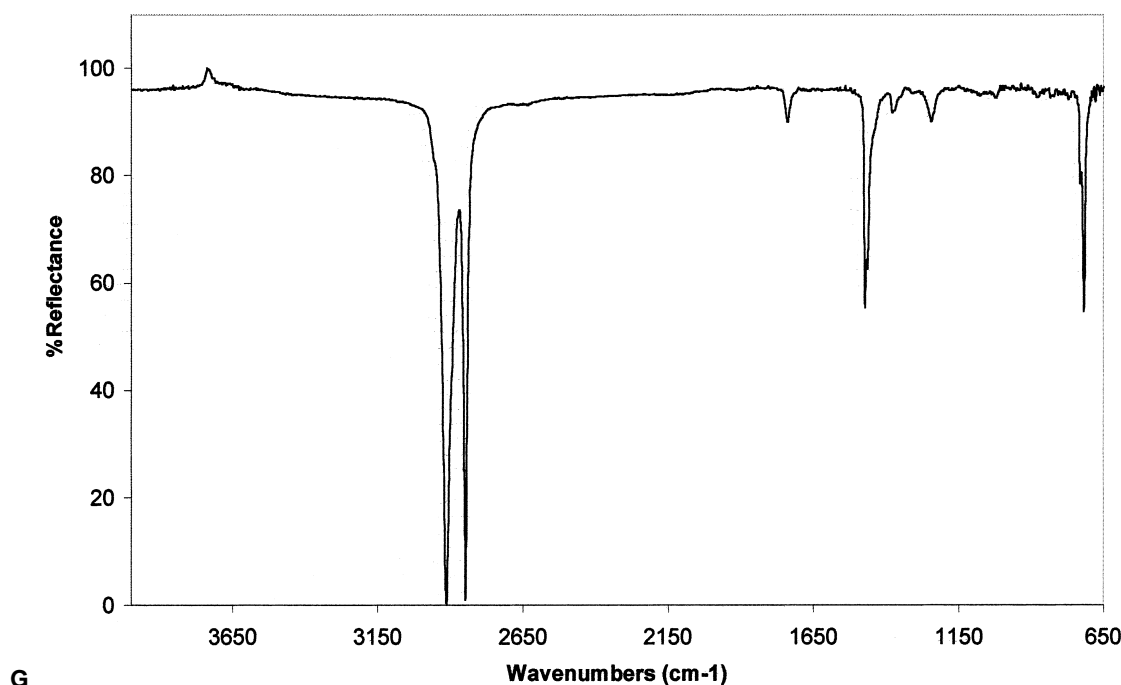


FIG. 4—(Continued).

TABLE 4—Groups discriminated by FT-IR microscopy (Zn-Se ATR).

FT-IR Group	Peaks Present in Spectrum (cm <sup>-1</sup> )
A	720, 1400, 1480, 2850, 2910
B	840, 960, 1000, 1170, 1370, 1460, 2830, 2870, 2920, 2950
C	680, 830, 960, 1080, 1170, 1250, 1330, 1430, 1460, 1730, 2850, 2930, 2960
D	740, 890, 1040, 1060, 1140, 1220, 1360, 1410, 1740, 2850, 2920, 2980
E	720, 780, 840, 870, 970, 1020, 1100, 1240, 1340, 1410, 1470, 1510, 1580, 1710, 1960, 2900, 2970, 3430
F	As for Group A, plus additional peak at 1740
G	As for Group A, plus two additional peaks at 1250 and 1740

lene samples. The FT-IR spectrum of Group F is included in Fig. 4 (f).

Two of the polyethylene samples, Robs' Long Life Vegetable Storage Bags (Samples 43–44/Group G), have both the peaks at approximately 1740 cm<sup>-1</sup> and one more peak at approximately 1250 cm<sup>-1</sup> which helps them to be discriminated from the other polyethylene samples. The peak is probably due to colored dyes used in manufacture, as the bags are both green (and of the same brand). The FT-IR spectrum of Group G is included in Fig. 4 (g).

Peaks present in the spectra of each FT-IR group are indicated in Table 4.

#### Suggested Sequence of Analysis

The flow chart which follows (Fig. 5) summarizes the techniques available, and the order in which they should be applied in carrying out an analysis of plastic drug packaging material.

Once all of this data is collected, the "Australian Database of Drug Packaging Materials" can be used as an aid for the identification of the origin of the packaging. Alternatively, the database can be consulted after each different technique, to help decide which additional techniques should be utilized to achieve further discrimination. An example of a database entry is shown in Fig. 6.

It should be noted that the application of this database is not limited to drug related evidence, but can be applied to any case involving plastic packaging material.

There are a number of conclusions that may be drawn after completion of the sequence of analysis. These conclusions include whether the bags or pieces of film were or were not: (a) manufactured from the same type of polymer; (b) manufactured from the same chemical batch or formulation of a certain polymer; (c) produced on the same machinery; (d) directly connected during manufacture (i.e., adjacent on the same large piece of plastic film before cutting into bags or lengths of film).

#### Blind Tests

The results of the blind tests are given in Table 5.

The blind tests confirmed that UV-vis and FT-IR spectra are not particularly helpful in discriminating samples of the same base polymer or within the same packaging type. Each of the blind test samples was manufactured from polyethylene, and so had similar spectra.

The correct result was obtained for four of the five blind tests carried out. The discrepancy with the result for the remaining blind test can be explained by the fact that the test which excluded the correct packaging was the visualization with crossed polarizing filters. This supports the discussion above concerning the discriminating power for the crossed polarization technique. The examination is so selective that the result may be different simply due to a small amount of manufacturing variability for a specific product

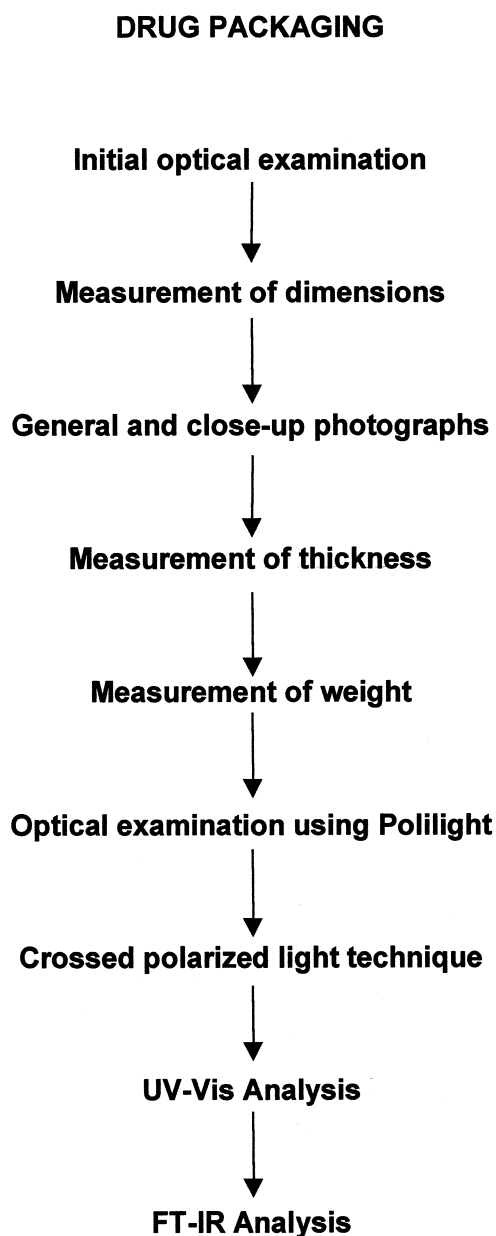


FIG. 5—Flow chart showing sequence of analysis for plastic drug packaging materials.

(e.g., produced on a different machine). In other words, the crossed polarizing filters technique is able to discriminate between two samples of the same product but from different batches. The extent of this within-product variability was not investigated in the current project. It should also be noted that it was not possible to discount the possibility that the manufacturer of No Frills Cling Wrap purchased film for this product from the same source as the Farmland Clear Wrap. This would explain the similarities observed between these two products.

#### “Living” Database

There are a number of possible ways that plastic packaging material can be manufactured. The company that manufactures the

end product may also produce the polymer resin from which it is manufactured, i.e., the company manufactures the product from start to finish. However, this is a rare situation. The company may buy the polymer resin and then manufacture the end product. On the other hand, the company may buy lengths of plastic tubing, and then cut bags or lengths of film from this tubing. In some cases, the bags are bought pre-manufactured, and are simply packaged by the company before sale.

If all of these factors remained constant for a single product, there would not be a problem. The problem lies in the fact that the companies which produce plastic packaging often have several suppliers for the same ingredients or intermediate products. Companies may change suppliers for a certain material depending on cost, reliability, and a number of other possible factors.

Sometimes an entire process may be changed due to technological improvements in machinery, or chemical ingredients may be changed due to health, safety, or environmental concerns (for example, the change from PVC to polyethylene in clingwraps).

While these are indeed limitations in the current database, it has proven to be of valuable assistance in the identification of plastic packaging material.

To ensure that this valuable role is maintained in the face of continuing technological developments in the plastic packaging industry, it is essential that such a database be flexible; it should be a “living” database capable of being regularly updated and expanded to accommodate new materials, packaging, and manufacturing developments. The “Australian Database of Drug Packaging Materials,” created as part of this research, is intended to serve as a foundation for this type of data collection.

#### Conclusion

Seventy-seven samples of plastic packaging materials, from Australia and Asia, commonly associated with illicit drug seizures, were examined using a range of optical, physical, and chemical techniques. The evidential value of these types of examinations was investigated. Any significant differences between the samples were determined, and the results of the analyses were used to construct an “Australian Database of Drug Packaging Materials.”

The overall conclusion is that the properties of common plastic packaging materials can be excellent indicators for identifying the specific brand or origin of the packaging. The initial optical examination was found to be the most effective step for discriminating different samples. Thickness and weight measurements also provided useful information. Observations using crossed-polarized light were found to be useful in specific cases, involving comparisons, but the technique is of limited application in a database situation. UV-vis spectrophotometry has some value for distinguishing samples. FT-IR was found to be a good initial test to determine the

TABLE 5—Blind test results.

Blind Test Number	Blind Test Result	Correct Result
1	Clear Wrap/Farmland	Cling Wrap/No Frills
2	Glad Wrap/Glad	Glad Wrap/Glad
3	Cling Wrap/Oso	Cling Wrap/Oso
4	Small Snap-lock Bags/Glad	Small Snap-lock Bags/Glad
5	Small FreezerBags/ Multix	Small Freezer Bags/ Multix

# Sample Number 14

**Packaging Type** Snaplock bag  
**Packaging Name/Brand** Ziploc Pleated Freezer  
**Origin of Sample** Australia  
**Date of Purchase** 9/07/97  
**Place of Purchase** Coles - Sylvania  
**Nominal Size** 26.82 x 18.41 x 8.89cm

General Photograph



**MEASUREMENTS**

<b>Width</b>	26.8cm	<b>Length</b>	20.6cm	<b>Depth</b>	9.2cm
<b>Length of Hem</b>	N/A	<b>Length above top seal</b>	1.8cm		

**Presence of Printing/Labels** Yes, see photo

**General Description**

Colorless transparent snaplock bag with two heat-sealed side edges and folded base. Incorporates 5.8 x 15.9 cm white write-on label in the center, with printing, and grip sections present above the snaplock seal.

**Method of Sealing** White snap-lock seal

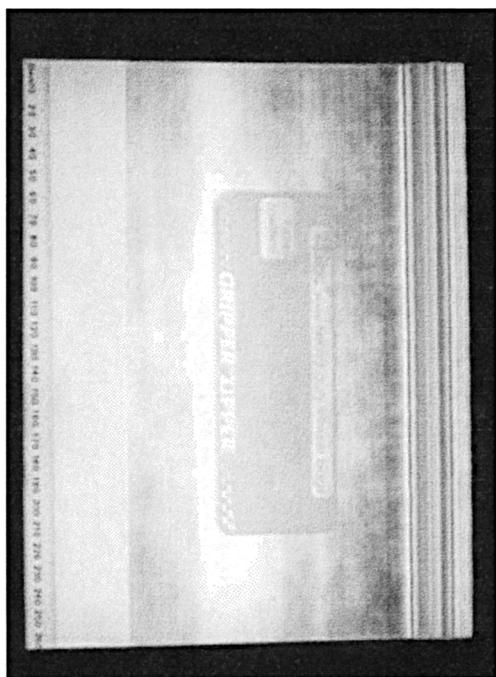
**Polymer Type** Polyethylene

**Single Sheet Thickness** 0.070mm

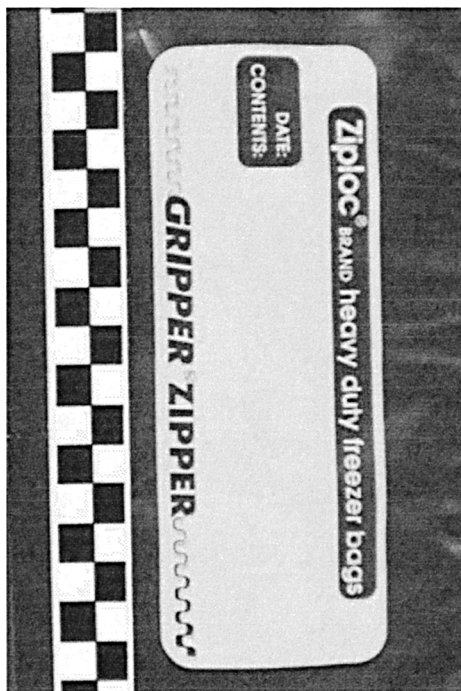
**Weight** N/A

FIG. 6—Part I.

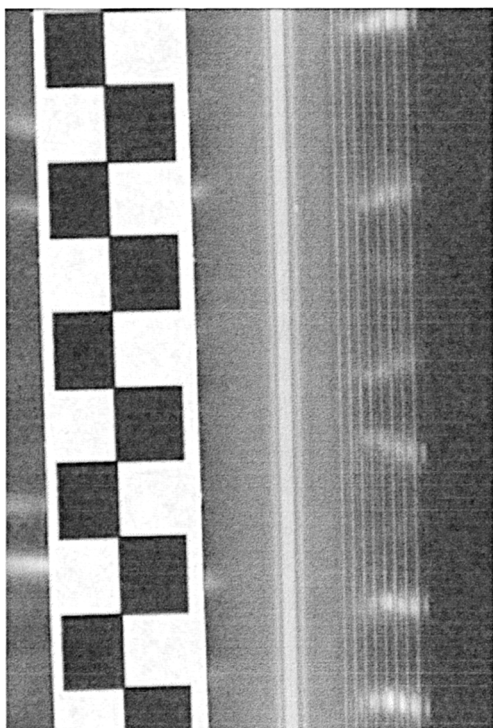
Viewed through crossed polarisers



Close-up of label



Close-up of snap-lock seal and grip pattern



White snap-lock seal through microscope

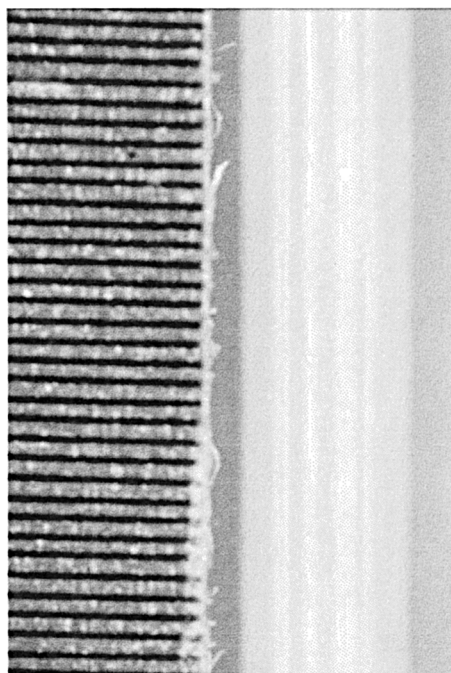
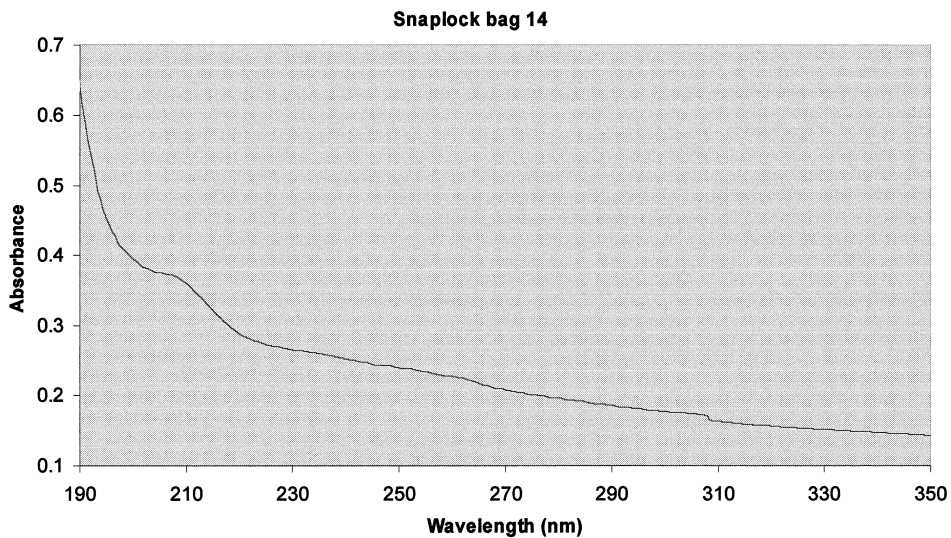


FIG. 6—Part 2.

UV-Visible Spectrum

UV-Visible Group 1



FTIR Spectrum

FTIR Group F

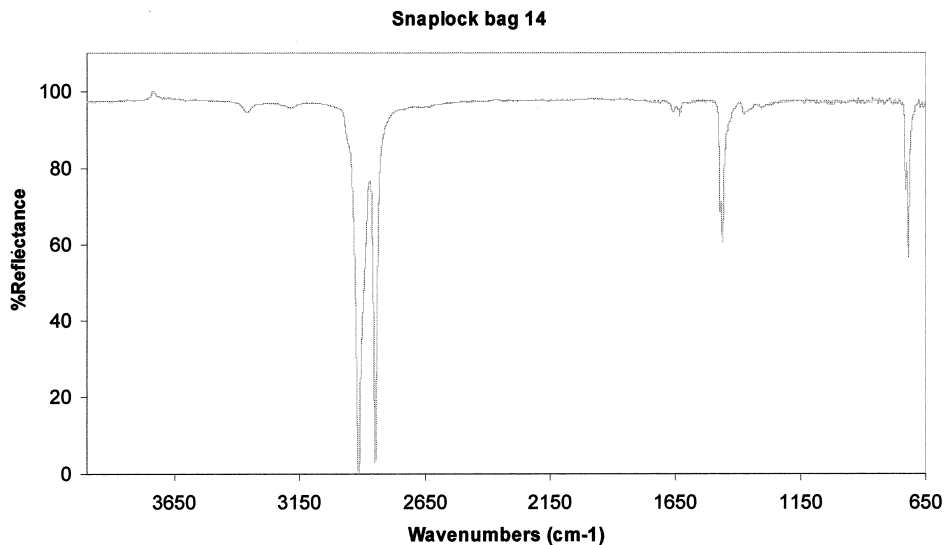
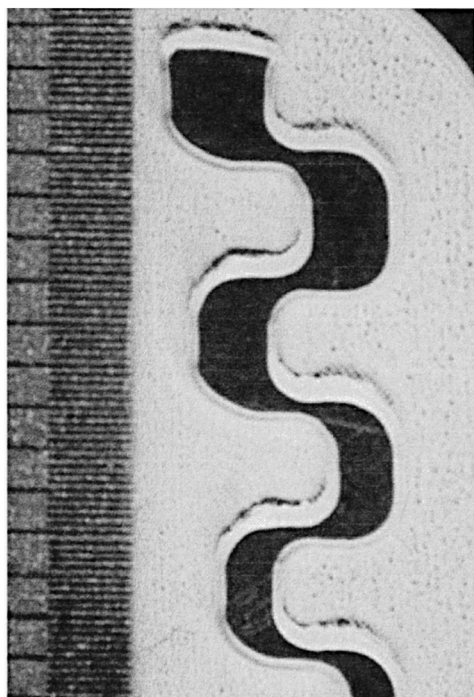


FIG. 6—Part 3. Example of a record from the “Australian Database of Drug Packaging Materials.”

Printing through microscope



Printing through microscope

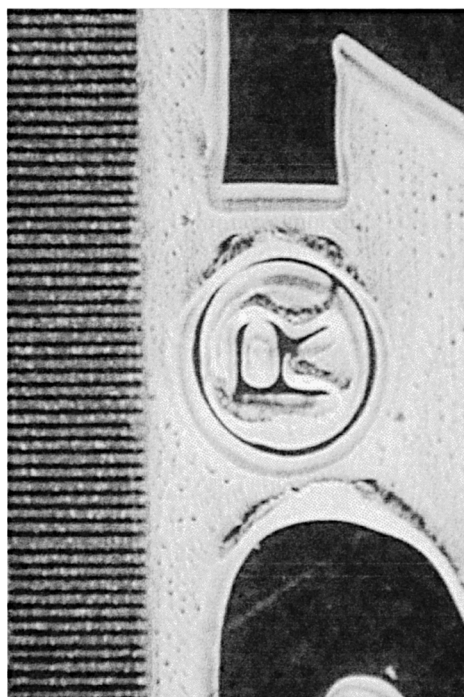


FIG. 6—(Continued).

base polymer of which the packaging was manufactured. Visual examination under different filtered light conditions was unable to discriminate the samples examined for the database but may still prove useful with some samples. Some differences between Australian and Asian samples were observed. Both the initial visual examination and the FT-IR analysis were of particular value in this respect.

The "Australian Database of Drug Packaging Materials," which was created as part of this research, systematically collates all of the analytical data for application on personal computers. The database will serve as an invaluable aid for drug intelligence purposes or for any case involving plastic packaging material as potential evidence.

#### Acknowledgments

The authors are grateful to members of the Physical Evidence sections of the Australian Federal Police and the Criminalistics Special Advisory Group members who completed our survey. We acknowledge the Australian Federal Police overseas liaison officers who supplied samples of plastic packaging materials available on the Asian market. We would also like to thank Mr. Graham Donald from NationalPak and Mr. Greg Miller from the Andrew Cohn Company for providing us with plastic samples and useful information.

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