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Snap-lock bags with red band: A study of manufacturing characteristics, thermal and chemical properties

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ABSTRACT

Drug packaging is commonly submitted to the Forensic Chemistry and Physics Laboratory of the Health Sciences Authority, Singapore, for examination. The drugs seized are often packaged in plastic bags. These bags are examined for linkages to provide law enforcement with useful associations between the traffickers and drug abusers.

The plastic bags submitted may include snap-lock bags, some with a red band located above the snap-lock closure and some without. Current techniques for examination involve looking at the physical characteristics (dimensions, thickness and polarising patterns) and manufacturing marks of these bags. In cases where manufacturing marks on the main body of the bags are poor or absent, the manufacturing characteristics present on the red band can be examined.

A study involving approximately 1000 bags was conducted to better understand the variations in the manufacturing characteristics of the red band. This understanding is crucial in helping to determine associations/eliminations between bags. Two instrumental techniques, namely differential scanning calorimetry (DSC) and Fourier transform infrared spectroscopy (FT-IR) were explored to evaluate the effectiveness of examining the chemical composition to discriminate the bags.

1. Introduction

Drug packaging is one form of evidence type commonly submitted for examination. Drugs seized are often found packaged in plastic bags [1] and when linkages between these bags are found, they can provide law enforcement with useful associations linking the traffickers and drug abusers. Physical and chemical methods for the examination and comparison of plastic bags [2] have been described in literature. Physical methods include the examination of physical characteristics such as the design, dimensions and polarising patterns of the plastic bags, while chemical methods range from infrared spectroscopy to UV–vis spectrophotometry [1].

In Singapore, one of the more prevalent types of drug packaging material would be snap-lock bags; also known by their many other names like resealable bags or grip-seal bags. The snap-lock bags that are submitted can vary in size and design, with the most common ones measuring approximately 2″ by 3″ and having a red band above the snap-lock region (Fig. 1).

The highest level of association that can be reached is to determine that bags are manufactured by the same machine through the identification of consecutively manufactured bags. This is done by examining the manufacturing marks (die and mandrel striations) [3] and pigment bands [4] that were imparted onto the plastic film during its manufacturing process. However, the quality and quantity of the manufacturing characteristics on the plastic film may differ depending on the condition of the die and mandrel. In certain cases, manufacturing characteristics on the main body of the snap-lock bag may be poor or even absent, making it difficult to determine if the bags were manufactured by the same machine.

Manufacturing characteristics at the red band region of the snap-lock bags have previously been used to complement the characteristics at the other regions of the bag in determining sequences. This is possible due to the red band being extruded onto the bags before the bags are cut and heat-sealed. However, there have been no reported cases where associations between bags were formed primarily based on the manufacturing characteristics at the red band region. The purpose of this paper would be to determine whether examination of manufacturing characteristics at the red band region can be sufficient to establish sequences of consecutively manufactured bags.

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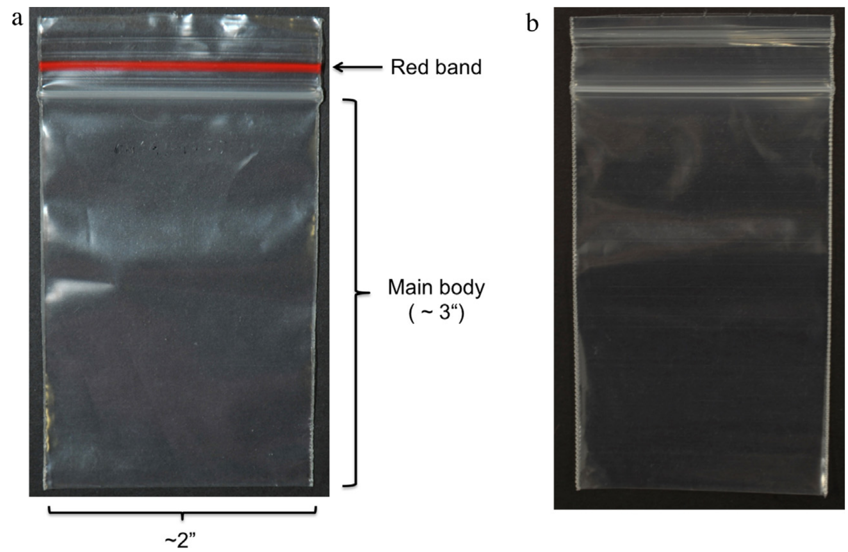

Fig. 1. Photograph showing a typical snap-lock bag with: (a) red band above its snap-lock closure; (b) no red band above its snap-lock closure. (The reader is referred to the web version of the article for coloured photographs.)

In addition, preliminary studies using techniques such as Fourier transform infrared spectroscopy (FT-IR) and differential scanning calorimetry (DSC) were also conducted to evaluate the usefulness of chemical methods in providing associations/eliminations when fragments or incomplete bags are submitted.

2. Material and methods

2.1. Samples

One packet of plastic snap-lock bags (*ca.* 2″ × 3″) was purchased from each of ten different locations throughout Singapore. Each packet contained approximately 100 snap-lock bags, with each bag being clear and colourless, having a folded bottom with two heat-sealed sides, and a red band above its snap-lock closure. For ease of reference, the snap-lock bag will be divided into two regions; (a) red band region and (b) main body (refers to regions of the bag below that of the snap-lock closure).

2.2. Examination of manufacturing characteristics

The bags were examined using a Leica FSC comparison microscope under transmitted light. Sequences of consecutively manufactured bags within each packet were determined by at least two qualified examiners, each having at least 2 years casework experience.

2.3. Fourier transform infrared spectroscopy (FT-IR)

IR absorption spectra were acquired using a Nicolet iN10MX Microscope and iZ10 FT-IR in transmission mode and the detector used was of the DTGS type. 36 scans were collected in the acquisition of the IR spectrum of each sample. To account for variations within each bag, samples were taken at the red band and snap-lock regions as well as the main body. Thereafter, three bags were sampled at the main body from each of the ten packets of bags.

2.4. Differential scanning calorimetry (DSC)

The samples were measured using a Shimadzu DSC-60A under N_2 atmosphere. Three bags were sampled from each packet, with each sample taken from the main body of the bag, weighing about 3 mg and enclosed in aluminium pans. The following conditions were applied to the samples: heating rate of 15 °C/min to 140 °C, followed by cooling at −5 °C/min to 30 °C and heating back to 140 °C at a rate of 15 °C/min.

3. Results and discussion

3.1. Comparison and identification of manufacturing marks on plastic bags

The criterion for the comparison and identification of manufacturing marks on the bags draws its basis from the Association of Firearm and Toolmark Examiners' (AFTE) Theory of Identification [5]. The theory allows for opinions of common origin to be made when the unique contours of two marks are in sufficient agreement. The schematic diagram (Fig. 2) shows bags which are manufactured consecutively, and by finding the linkages due to sufficient agreement of random microscopic striations (i.e., "individual characteristics" as defined by AFTE), we are able to determine that the bags were manufactured by the same machine.

In determining sequences, the degree of correspondence required to constitute sufficient agreement for identification has to exceed that of the best known non-match (KNM). Best KNM as it pertains to the Theory of Identification refers to the "best agreement demonstrated between two toolmarks known to have been produced by different tools". By this definition, KNMs for plastic bags examination would refer to bags that have no significant differences in design and dimensions, and known to be manufactured by different machines/sources. As per our laboratory protocol, plastic bags are reported to have been manufactured by the same machine only if they could be determined to have been manufactured consecutively. This is illustrated using an example featuring three bags that have been manufactured consecutively (Fig. 3). As such, the best KNM as it relates to plastic bags examination used by the laboratory differs in that more stringent conditions are applied and refers to bags within a manufacturing sequence that are not consecutively manufactured.

In addition, it is also important to have a sufficient number of bags in order to observe the variations in manufacturing characteristics among the bags and to determine the best KNM. Fig. 4 provides examples of KNMs that can be considered depending on the number of bags available.