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A population study of polyurethane foam fragments recovered from the surface of 100 outer-garments

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ABSTRACT

One hundred outer-garments were examined for microscopic fragments of polyurethane foam. Low power stereomicroscopy was used to classify fragments into 18 groups according to macroscopic colour. Amber, pale yellow and black were the most frequently encountered, whilst navy, pale blue, bright pink, beige, brown, pale green, peach and white were the least frequently encountered. High power comparison/fluorescence microscopy was used to discriminate 166 populations within 16 colour groupings. The majority (95.2%) of populations consisted of three fragments or less. This study demonstrates that the background population of foam fragments on an outer-garment consists of low numbers representing various colours. Therefore, finding a large population of microscopically indistinguishable fragments within a casework situation has the potential to be considered highly significant evidentially.

1. Introduction

Trace evidence can be defined as microscopic fragments of material that, in accordance with Locard's Exchange Principle, can provide evidence of contact between the item from which it has been recovered and a potential source of that material, thus establishing a forensic link between suspect, victim and/or crime scene. Frequently encountered forms of trace evidence in forensic casework include textile fibres, paint flakes, and glass fragments, though it is possible for any material to be considered as a form of trace evidence if it is capable of being transferred, recovered, analysed and compared to demonstrate its similarity or difference to a potential source, giving it some degree of evidential worth. In recent years, researchers have highlighted the potential for microscopic fragments of polyurethane foam to be considered as a form of trace evidence.

Wiggins et al. [1], responding to a specific casework enquiry, conducted a study into the transfer and persistence of microscopic fragments of polyurethane foam onto cotton/denim clothing material. They discovered that, much in the same way as textile fibres, large numbers of foam fragments were capable of transferring to a recipient surface upon initial contact, but that within the subsequent 4 h after contact, the vast majority will be lost under normal wear conditions. Parsons and Mountain [2], investigated the physical and chemical characteristics of polyurethane foam with a view to establishing if foam from different sources could be distinguished, using a similar analytical approach to that applied in the forensic examination of textile fibres. Both low power stereomicroscopy and high power comparison/fluorescence microscopy were used to examine foam fragments with respect to their morphology, colour and behaviour under different lighting conditions. Visible range microspectrophotometry (MSP) was also employed to explore the possibility of further discrimination of microscopically indistinguishable fragments on the basis of spectral characteristics arising from their dye composition. It was reported that where foam from the same source was analysed using these techniques, no microscopical or chemical variation was observed. Moreover, sufficient variation was observed in these respects in the comparison of foam from different sources, thus providing a means of discrimination. These studies have demonstrated that fragments of polyurethane foam exhibit the characteristics associated with being a type of trace evidence. However, to date no research has been reported in the literature that attempts to address the question as to what level of evidential value can be placed on the finding of indistinguishable fragments within a casework scenario.

Determining evidential value of a particular form of trace material, whether it is glass, fibres or foam, requires the careful consideration of a number of factors. In addition to some knowledge as to the transfer and persistence behaviour of the trace material under certain conditions,

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another key consideration is the likelihood of finding a "match" by pure chance. It should be qualified at this point what is meant by the term "match", since it is a term that will be used throughout this study. With regard to polyurethane foam, a match would be where two or more fragments were found to exhibit characteristics such that they are considered indistinguishable to one another in respect of all analyses performed. Generally, where trace material exhibiting similar characteristics is considered common, the likelihood of a coincidental match is high, reducing its evidential value. Conversely, where the trace material is considered less common, its evidential value will be much higher as the likelihood of a chance match will be low. However, this alone is not sufficient to determine evidential value. It is also necessary to have some appreciation as to what one would expect to find in terms of the background population of that trace material on a similar surface selected at random. This allows the forensic scientist to consider the findings of his examinations against his expectations, enabling him to form an opinion as to the strength of their evidential significance in light of the case circumstances. Information about the normal background population on a given surface can be attained from a population study which is designed to assess the content of a randomly sampled trace population on a particular surface at a given time and geographical location.

To assist in determining the evidential value of polyurethane foam fragments as a form of trace evidence, it is necessary to have some information as to the prevalence of certain types and colours present within the general population. A population study would be useful in assessing the likelihood of finding a certain type/colour combination of foam fragment present on a particular surface. It has been reported [2] that some level of discrimination between foam fragments is possible based on morphological characteristics, although this is limited owing to the extremely small sample size likely to be encountered in forensic casework. However, the one characteristic that can be used to discriminate between all polyurethane foam fragments is colour. Therefore, the aim of this work was to carry out a population study of polyurethane foam fragments present on the surfaces of a number of outer-clothing garments, with classification of fragments based primarily on macroscopic colour. It is hoped the results will serve as an aid to interpretation of evidential significance of finding a population of matching foam fragments within casework.

2. Materials and methods

2.1. Clothing collection

One hundred (100) items of outer-clothing were collected from a variety of sources. For the purposes of this study, an article of outer-clothing was considered to be any garment that could be worn as an outermost garment, i.e. trousers, dresses/skirts, shirts, fleeces/hoodies and coats/jackets. Given that this study was initially conducted during the summer months of 2006, t shirts were also considered to be outer-clothing. Table 1 shows a description of each garment collected, together with the number of pockets present on each and a classification as to their retentive properties, i.e. an opinion as to the ability of the surface of the item to retain debris such as polyurethane foam fragments and other forms of trace evidence.

The clothing was sourced from colleagues at LGC Forensics Oxfordshire laboratory, friends of the authors, and two charity shops located in Oxfordshire and Dorset. Several items frequently originated from the same source, e.g. item #s 1–30 came from charity shop A. A request was made that all items to be used in the study, where possible, were not recently laundered so as to maximise the potential for recovery of foam fragments from the surfaces and pockets. In addition, garments were to be packaged individually in separate plastic carrier bags to minimise the risk of contamination between different items. However, items that were collected from charity shop A were packaged together in two black bin liner bags (denoted A(1) and A(2), respectively, in Table 1); moreover, no information as to their laundry history prior to their donation to the charity shop was available. It is possible that these items were laundered immediately prior to donation, and it should, therefore, be noted that this may have influenced the number of foam fragments recovered from these particular items.

2.2. Debris collection

The shaking method of recovery [3] was considered the most appropriate for this study, primarily due to its rapid and simple nature, but also due to experience from casework in which foam fragments were frequently observed in debris collected from shaken garments [2]. Several precautions were taken to reduce the risk of contamination of debris recovered between different garments. The work surface was wiped over with a disinfectant (Presept) using a paper towel before and after each garment. A fresh piece of brown parcel paper was laid onto the work surface for each garment, onto which the shaken debris was initially collected. A new pair of latex gloves was worn for handling each item. Debris was collected from the surface of each item by shaking the garment vigorously over the brown parcel paper for several seconds. The debris was then transferred to a clean petri dish and labelled accordingly. For those garments with pockets, once the surface debris had been collected and transferred to a petri dish, the pockets were turned inside out and shaken vigorously over brown parcel paper. The debris from all pockets of a single garment was recovered together, transferred to a clean petri dish and labelled accordingly.

Subsequent examination of the recovered polyurethane foam fragments followed, in part, recommendations made in a previous study [2]: using low power stereomicroscopy, a subjective assessment of macroscopic colour and any distinctive morphological characteristics were noted, and then the appearance and behaviour of fragments under different lighting conditions were assessed using high power comparison/fluorescence microscopy. Further objective comparison of colour by microspectrophotometry was not performed. For a more detailed discussion of the structural features and colouration of polyurethane foam, as well as its general manufacture and applications, the reader is referred to Parsons and Mountain [2].

2.3. Low power microscopy

A Leica MZ6 low power stereomicroscope (magnification×32) was used to initially examine and search each petri dish for microscopic fragments of polyurethane foam. All observed foam was removed from the pots by fine forceps and transferred to a gel lift. Each fragment was subsequently mounted individually onto a glass microscope slide and sealed under a cover slip. Departing from the published method [2], Entellan was used as the mounting media as opposed to Xam, which was no longer available under European Directive 98/79/EC at the time this study was carried out [4]. To enable subsequent examination by comparison microscopy, no two fragments of the same generic colour recovered from a single item were mounted onto the same microscope slide. Additionally, where a large number of foam fragments of the same generic colour were recovered from a single item, a maximum number of ten fragments of that colour were mounted for further examination. Remaining fragments were left in situ on the gel lift.

The generic colour of each foam fragment and the number of fragments of each colour recovered from the surface and pockets (if relevant) were recorded. Any unusual (morphological) features observed under low power microscopy were also recorded as a means to provide further discrimination between different populations of polyurethane foam. Such features included differences in structure (i.e. miniature strut lengths) or in the use of pigments over dyes, the former of which could be identified by a speckled appearance of colour within the fragment, generally only observed once viewed under the stereomicroscope (Fig. 1).