

TECHNICAL NOTE

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Paint and Tape: Collection and Storage of Microtraces of Paint in Adhesive Tape

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ABSTRACT: The collection and preservation of microtrace evidence with the aid of an adhesive tape is a method of choice in forensic science. This technique is rapid and easy and allows the concentration of microtraces on a carrier, which facilitates further investigations in the laboratory. Adhesive tapes are currently used to secure microtraces of fibers and glass, but hardly for traces of automotive paint and other lacquers for fear of interference with the analysis of binders. A collection of automotive paint consisting of original and repair lacquers collected by tape has been evaluated. After various times of storage within the tape, these samples were compared with untreated references by microscope FT-IR and microspectrophotometry (MSP). Another set of paints was collected in 1984, stored within the tape until 1995, and examined the same way. About 170 layers of lacquer with various types of binder were examined. With the exception of one clear lacquer no difference between treated samples and references was detected. This small difference observed could be correlated to the exposure to xylene (extractant) and was not caused by the storage within the adhesive tape.

KEYWORDS: forensic science, criminalistics, adhesive tape, automotive paint, FT-IR spectroscopy, microtrace, paint, collection, storage

The collection and preservation of evidence with the aid of an adhesive tape was initially proposed by Frei-Sulzer in 1951 (1). During the following years this technique was improved through its routine use (3). It has proved rapid and easy and has allowed concentration of microtraces on a small area, thus facilitating further investigations. The collecting power has been demonstrated (2). Because of these advantages, adhesive tapes are now employed widely in forensic science. Unfortunately the advantages are counterbalanced by potential problems and interferences by the adhesive material itself. Depending on the constituents of the collected microtraces, it might be quite tedious and time consuming to prepare the collected evidence for further evaluations by removal from the tape. Thus, for efficient preparation and removal of fibers out of adhesive tapes, xylene is used in our laboratory. Until now there are few indications that during this short contact xylene affects syn-

thetic or natural fibers (4,5). This solvent has excellent qualities with respect to the removal of polyacrylate-based adhesives. Further advantages are its comparative low volatility and toxicity compared to other aromatics.

Many objects of our environment are coated with paint; thus, paint traces make up for a fair amount of material that has to be analyzed in forensic laboratories. In many cases, especially for traffic accidents, it offers valuable evidence (7). For this reason paint traces occupy a prominent place in our laboratory, and for 20 years the tape method has been used to collect paint microtraces in our service. The collected paint chips are routinely evaluated by microscopic and spectroscopical methods as well as with SEM/EDX. Until now we had no indication of problems originating through the use of the tape in combination with xylene. Extensive and systematic investigations demonstrated the neutrality of the method for fiber analysis (4) but little knowledge was available about the possible impact of the tape and subsequent treatments on paint samples. Because spectroscopical methods (FT-IR and MSP) with high discriminating power have become used in regular casework, it was decided to investigate the short-term as well as the long-term influence of tape on paint and lacquer samples collected and stored for up to ten years. The effect of subsequent solvent removal of the sample from the adhesive was also studied. A collection of paints and lacquers, collected in 1984 and 1994, was selected for evaluation.

Materials and Methods

For the collection of samples, we currently use a tape consisting of a polypropylene backing and polyacrylate adhesive. It is available under the trade name Sellotape 1250 (Sellotape AG, 9400 Rorschach, Switzerland). A set of 22 multilayered automotive paints consisting of original and repair lacquers collected during August and October 1994 was stored between two layers of adhesive tape in the dark for 2 to 7 months until further preparation. Another part of our investigations was made with a set of 21 paint samples collected from different types of lacquers in the year 1984 and taken up into the tape after collection. At that time we used our previous tape (Tesa 5532, PVC carrier), which also had a polyacrylate-based adhesive. This tape has chemical and physical properties very similar to those of Sellotape 1250. From every paint sample a control was stored as a reference under identical conditions (complete darkness) except for the contact to tape.

Samples for analysis were prepared using a scalpel to cut a paint chip together with some supporting tape. This sectioned material was immersed in a drop of solvent (mainly xylene, compare "Re-

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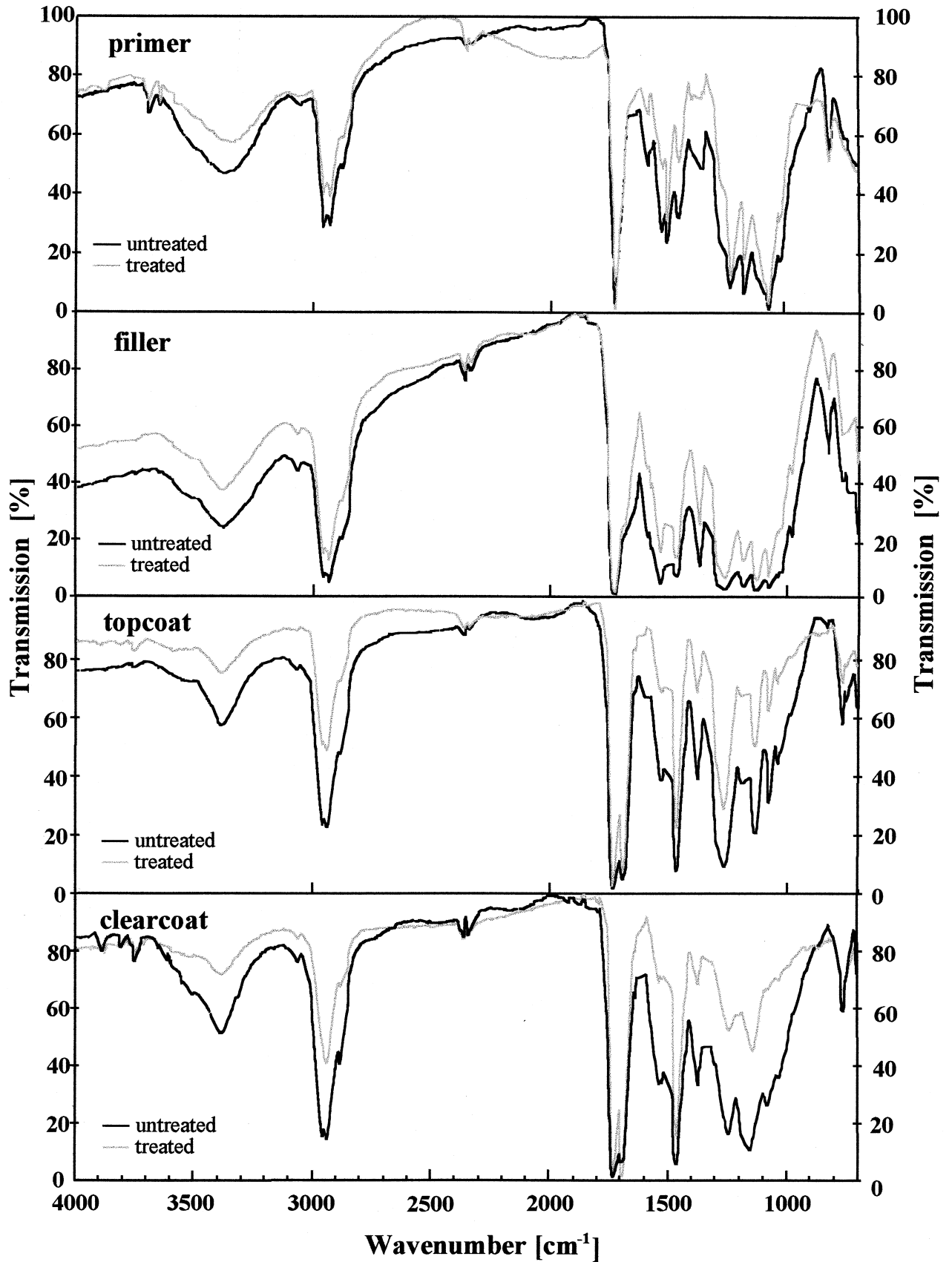


FIG. 1—Normalized FT-IR spectra of the 4 inner original paint layers of the same automotive paint, recorded through an IR microscope at a magnification of $150\times$ (thickness $4\ \mu\text{m}$, transmission mode). The two spectra of each layer are recorded from an untreated paint chip and a paint chip stored in adhesive tape and subsequently extracted with xylene.

sults and Discussion”) and the residual tape and most of the adhesive was removed with scalpel, tweezers, and a preparation needle. Samples and references were treated equally with respect to any other aspect as to the storage in the tape and to the preparation out of it.

FT-IR spectra from all the layers of both control and taped samples have been recorded. Small chips (1 mm² and larger) were fixed onto the tip of a toothpick with epoxy glue and embedded into poly-hydroxyethyl-methacrylate blocks (Technovite 7001, Kulzer Histotechnik, D-61237 Wehrheim). Four μm sections were cut from the methacrylate blocks with a microtome and subjected to transmission FT-IR microspectrometry on a NaCl disk (spectral range 4000 to 700 cm^{-1}). UV/VIS transmission spectra (250 to 700 nm) were recorded with an MSP of such sections using glycerol as immersion medium (4,6). For some paints, in addition, the optical properties were assessed under the fluorescence microscope with excitation in the regions of 360, 390, 470, and 540 nm using a deuterium light source.

Results and Discussion

Twenty-two multilayered automotive paints with more than 120 layers of lacquers collected during 1994 from cars damaged in

accidents were investigated. Initially paint chips were taped and extracted out of it using various solvents (hexane, ethyl-acetate, chloroform, xylene, ethanol, and acetone). It turned out that the best working solvents were chloroform and xylene. With these two solvents the tape was easily peeled off the paint chips and remaining adhesive was removable with reasonable effort. The use of chloroform in routine work was rejected, because it was regarded to be too toxic and was not considered further in our research. Xylene interferes somewhat with the paint chips, making them bend, and in some cases an apparent color change was observed. Both effects vanished with the evaporation of the solvent. These solvent effects can be circumvented by using hexane or other hydrocarbons such as mineral spirit, but this increases manipulation time and difficulties in removing the polyacrylate adhesive from the paint chip.

In order to evaluate the effects of xylene against those of hexane, two chips of the same paint had been stored for at least two weeks within the tape. One chip was extracted from the tape with the help of hexane, the other with xylene. Together with an untreated chip as a reference, they were imbedded in poly-hydroxyethyl-methacrylate blocks, and 4 μm cross sections were used to record FT-IR spectra of each layer of lacquer (see “Materials and Methods”). All the corresponding paint layers examined showed the

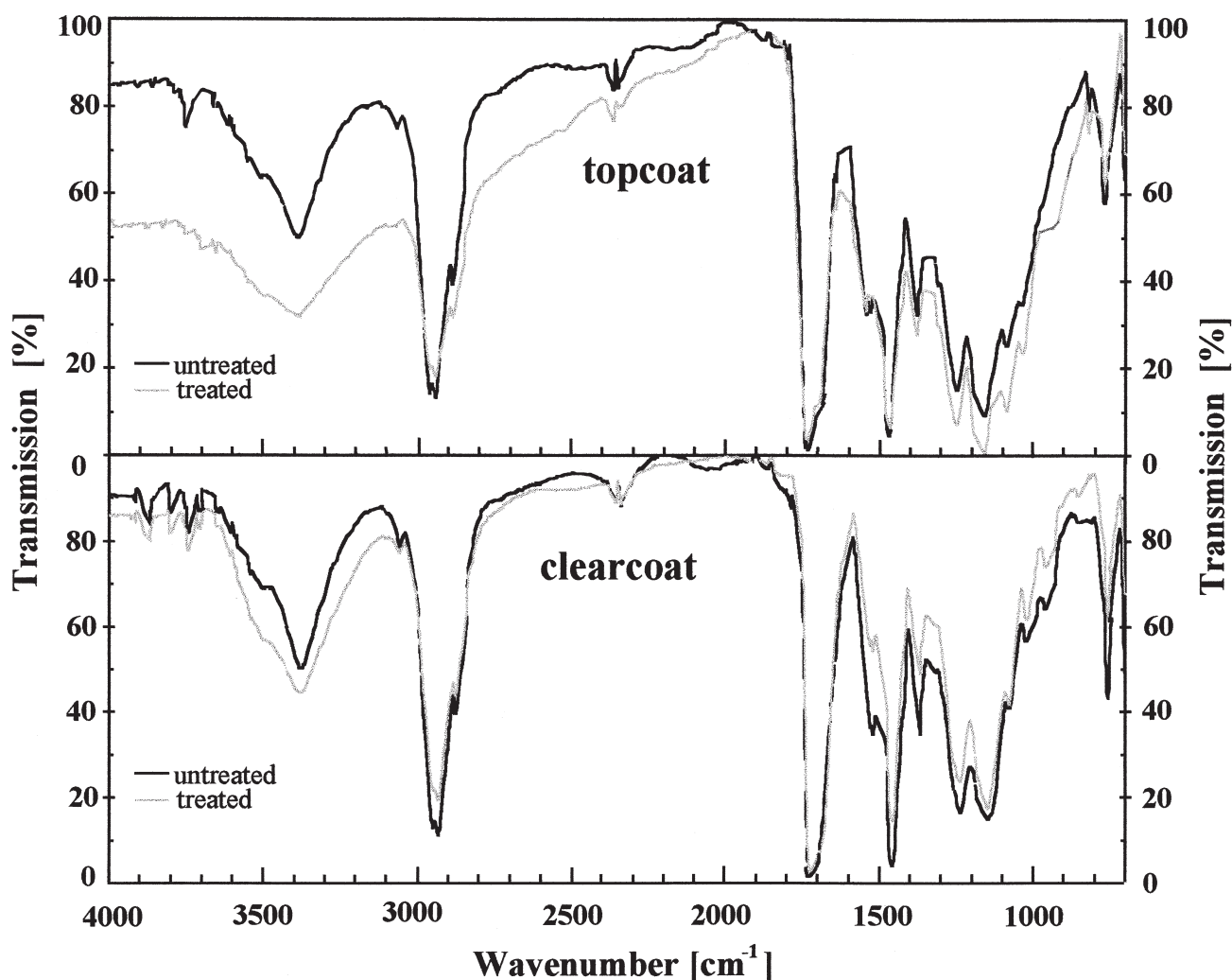


FIG. 2—Normalized FT-IR spectra of the two outer repair paint layers of the same automotive paint shown in Fig. 1, recorded through an IR microscope at a magnification of 150 \times (thickness 4 μm , transmission mode). The two spectra of each layer are recorded from an untreated paint chip and a paint chip stored in adhesive tape and subsequently prepared out of it with xylene.

same spectra, unaffected by their treatment with xylene or hexane. Consequently xylene was found to be the most convenient solvent to prepare paint chips out of the adhesive tape and was selected as the sole solvent for further experiments.

From each of the 22 automotive paints collected in 1994 samples were removed after 2 to 7 months of storage within the tape and were processed as described. Each paint layer was compared with the corresponding layer of the untreated paint chip. More than 120 layers of primers, fillers, topcoats, metallic topcoats, and clearcoats were investigated. No modification of the IR spectrum after storage in the tape and subsequent preparation with xylene was found (see Figs. 1 and 2).

Furthermore a representative population of layers of these automotive paints, both sample and reference, has been examined under the fluorescence microscope and by MSP. These investigations did not reveal any differences in their fluorescence characteristics, and the positions and relative intensities of peaks and shoulders in the MSP spectra were the same. These findings corroborate previous experience in our laboratory.

Similarly, another set of 21 lacquers and automotive paints from various sources (about 50 layers) were collected in 1984 and stored in the tape. They were treated as described. Xylene was used to extract the paint chips out of the tape and subsequently they were examined by FT-IR spectroscopy. Only one clear lacquer with air drying O-phthalic alkyd as binder showed a reproducible, but minute difference in the IR spectrum (data not shown) at 1279 cm^{-1} . In order to verify the source of the difference, the control was treated with xylene. Their IR spectra showed the same difference compared to the IR spectra of the untreated chips. This demonstrated that the difference originated from the exposure to xylene and was not caused by the long storage time within the tape.

Conclusions

This study demonstrates that polyacrylate-based adhesive tapes used in our laboratory to collect evidence do not have any measurable impact on the collected automotive paint chips tested. This was verified for a storage time in excess of 10 years. Based on the evidence of this paper and previous experience in our laboratory,

we assume that the majority of automotive and non-automotive paints and lacquers are collectable with this tape. In addition, one of the experiments shows that it also is possible to store these lacquers within the tape for a very long time without a detectable change in the examined spectroscopical properties. This powerful preparation method commonly used for fibers is thus applicable to routine microtraces collection including paint. This strongly facilitates collection and subsequent preparation of samples for further analytical evaluations.

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