

**Commentary on** Bernhard WR. Paint and tape: collection and storage of microtraces of paint in adhesive tape. *J Forensic Sci* 2000;45(6):1312–15.

Sir:

We read with interest Dr. W.R. Bernhard's paper, "Paint and tape collection and storage of microtraces of paint in adhesive tape," published on pages 1312 through 1315, Volume 45, Number 6 of the *Journal of Forensic Sciences*, November, 2000. It raised concerns on our part, as claims were made which did not appear to be supported by the published data. Furthermore, Dr. Bernhard states that xylene is an acceptable solvent to aid in the removal of paint fragments from the contact adhesive used to collect them. We are aware of obvious examples of the detrimental effect of solvents, such as xylene, on some paints. In order to further emphasize statements made in the Scientific Working Group for Materials Analysis (SWGAT) Forensic Paint Analysis and Comparison Guidelines (1), we feel it imperative that we comment on the author's conclusions.

The SWGMAT Forensic Paint Analysis and Comparison Guidelines state in paragraph 7.2.1, "When paint evidence is recognized, every effort should be made to manually remove it before using tape lifts to collect other types of evidence. If paint is collected with tape lifts, be aware of the possible difficulty encountered when attempting to manipulate paint samples bearing adhesive residues. In addition, components of the adhesive could contaminate the paint sample and change its apparent chemistry." The first sentence in this statement reflects the understanding that there are times when tape lifts will be used in the collection of paint. One such instance may be in the collection of general trace debris from the surface of a homicide victim's body or clothing. In that a variety of types of microtraces are sought in this instance, taping may very well be the most efficient means of collection. Upon microscopic examination of the debris present on the tape adhesive, the examiner may find flecks of paint that are of evidential value. The fact that they were collected with a contact adhesive does not negate their use, but it may complicate it. The two sentences following the first in the above quote serve to clarify what that complication may entail.

The first complication is removal from the adhesive. It can be done physically, but this is often difficult and may leave adhesive residue on the surfaces of the paint fragment. Sampling underneath the contaminated surface, by taking successive peels and only using the latter peels, may physically avoid any obvious interference produced by residual adhesive. Sample manipulation and contamination prevention is difficult, however. In response to that, Dr. Bernhard discusses the merits and pitfalls of using a variety of solvents to assist in the removal of the fragment from the contact adhesive on page 1314 of his paper. He states "Xylene interferes (sic) 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." He then goes on to describe one experiment on a paint sample where the effects of hexane were contrasted to those of xylene. He concludes "All the corresponding paint layers examined showed the 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." In contrast to this, we would like to call the reader's attention to the fact that xylene will not only extract some of the resin and plasticizers used in a variety of automotive and architectural paint binder systems, but it will also completely dissolve automotive acrylic dispersion lacquers (2). These dispersion lacquers are high solids resin systems that cure primarily by solvent evaporation, not by cross-linking. Dispersion lacquers were frequently used as original finish coats on hundreds of thousands of vehicles produced by General Motors Corporation from 1970 to 1992 (3,4). They are still routinely encountered as evidence in casework and may be used in automotive refinishes in the near future.

Resin (binder) extraction can be easily demonstrated by exposing several peels of a polyvinyl acetate-acrylic latex house paint to xylene, followed by evaporation of the recovered solvent on an infrared light transparent window. Subsequent infrared spectroscopic analysis of the deposit cast onto the window will permit recognition and identification of the partially extracted polymer. A similar situation occurs when an automotive acrylic solution lacquer is treated with xylene, resulting in a deposit of the partially dissolved acrylic resin onto the surface of the window. It is apparent what may occur when xylene is brought into contact with an intact multi-layered paint fragment composed of different binder systems in each of the layers. Effects would be amplified with minute samples and smears smaller than those adequate for microtomy.

The second complication is that of potential migration of components of the adhesive into the paint sample, with a resulting change in the apparent chemistry. Dr. Bernhard attempts to convince the reader that this will not happen with the examples presented in his study. Interpretation may have been aided if an infrared spectrum of the tape's contact adhesive was presented. Even without, however, we differ with his conclusion that the infrared spectra presented in Fig. 1 and 2 demonstrate the lack of substantial differences before and after exposure to the contact adhesive. In fact, we would suggest that the data support the introduction of significant differences following such exposure. Firstly, we would call the reader's attention to infrared light transmission differences in the spectra presented in the Fig. 1 primer, in both the 1300  $\text{cm}^{-1}$  and 850  $\text{cm}^{-1}$  regions of the spectra. This occurs again in the 1600  $\text{cm}^{-1}$  and 800  $\text{cm}^{-1}$  regions of the topcoat spectra and in both the 1100  $\text{cm}^{-1}$  to 1000  $\text{cm}^{-1}$  and the 3000  $\text{cm}^{-1}$  to 2900  $\text{cm}^{-1}$  regions of the clear coat spectra. Significant differences can again be seen in the 3750  $\text{cm}^{-1}$  and 1100  $\text{cm}^{-1}$  to 800  $\text{cm}^{-1}$  regions of the topcoat spectra as well as the 950  $\text{cm}^{-1}$  to 800  $\text{cm}^{-1}$  regions of the clear coat spectra presented in Fig. 2. To demonstrate that these differences are substantial in a paint comparison, we would direct the reader to several publications presenting comparisons of infrared spectra of coatings known to be different yet having very similar spectral patterns (5,6). These apparent small variations in the infrared spectra of coatings must not be dismissed as "close enough" when performing detailed comparisons. Paint production often utilizes a mixture of a number of chemically related, but different, precursors. They have individual infrared spectra that are quite similar. When mixed, they produce a composite infrared spectrum in the final product that may demonstrate only small differences when compared to a formulation employing similar yet different components. Pyrolysis gas chromatography may be used to corroborate this, as illustrated on pages 222 through 226 and page 41 of the respective references.

Another disturbing trend noted in the data presented can be found in the difference of the overall transmission intensity of the before and after sample spectra. The samples were both prepared by microtomed sectioning of embedded samples at a controlled four-micron section thickness. If samples were indeed unaffected and their path lengths the same, why then is there such an apparent discrepancy in the transmission intensities, such as that seen in the spectra presented in Fig. 1? We are at a loss for an explanation.

In light of all of these concerns, we feel the statement made in paragraph 7.2.1 of the SWGMAT Forensic Paint Analysis and Comparison Guidelines is appropriate advice when considering the use of contact adhesives for the collection of forensic paint evidence.

## References

1. Scientific working group for materials analysis. Forensic paint analysis and comparison guidelines. *Forensic Sci Communications* 1999;1:2, at <http://www.fbi.gov/hq/lab/fsc/backissu/july1999/painta.htm>.

## Authors' Response

Sir:

We received the letter to the editor from the esteemed Paint Subgroup of SWGMAT and would like to reply on the mentioned problems.

In our case work, we hardly encounter paint evidence that could be manually removed, mainly due to its small size. Our experience when collecting paint evidence at crime scenes or accident sites is we often only have the choice either to collect the evidence in tape or not to have any evidence available for examination.

As stated in the paper, we know that there are some effects of the xylene on some lacquers. The mentioned dispersion lacquers from old GMC cars are rarely found in our case materials. In addition it is evident for us to keep the exposure time of the solvent on the paint chip as short as possible and to treat evidence and reference material exactly the same way. For us, the mentioned possible resin (binder) extraction has not shown to be a problem in practice.

Regarding the claimed significant differences in the spectra we have checked the original spectra again. The correspondence between the spectra of the treated and untreated samples is much better than it appears in the published spectra. We do not know the reason for this artifact. We cannot find any influence of the adhesive

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5. Ryland SG. Infrared microspectroscopy of forensic paint evidence. In: Humecki HJ, editor. *Practical guide to infrared microspectroscopy*. New York: Marcel Dekker, Inc., 1995:163–243.
6. Ryland S, Bishea G, Brun-Conti L, Eyring M, Flanagan B, Jergovich T, et al. Discrimination of 1990s original automotive paint systems: a collaborative study of black nonmetallic base coat/clear coat finishes. *J Forensic Sci* 2001;46:1:31–45.

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*J Forensic Sci*, Sept. 2002, Vol. 47, No. 5  
Paper ID JFS2002126\_475  
Published 21 Aug. 2002  
Available online at: [www.astm.org](http://www.astm.org)

(2-ethylhexyl acrylate polymer) of our carefully selected tape for the collecting of evidence.

At the moment, we do not use Pyrolysis gas chromatography for routine examination of paint chips. So we do not know exactly if there would be seen any influence of the xylene or of the adhesive with this more sensitive technique.

The mentioned discrepancy in transmission intensities really exists in our spectra. At that time, there were some minor technical problems with the microtome. It was difficult to cut at a controlled four-micron section thickness. In the meantime we have changed to a hard metal blade and are getting more consistent results.

As a final conclusion—being aware of the practical problems resulting from collecting paint evidence with tape—we still consider that the advantages of the method clearly prevail the disadvantages.

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