



Paint Analysis

Test No. 24-5452 Summary Report

Each sample pack contained one known paint chip sample and two sets of questioned paint chips. Participants were asked to examine these items using their existing protocols. Data were returned from 69 participants and are compiled into the following tables:

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This report contains the data received from the participants in this test. Since these participants are located in many countries around the world, and it is their option how the samples are to be used (e.g., training exercise, known or blind proficiency testing, research and development of new techniques, etc.), the results compiled in the Summary Report are not intended to be an overview of the quality of work performed in the profession and cannot be interpreted as such. The Summary Comments are included for the benefit of participants to assist with maintaining or enhancing the quality of their results. These comments are not intended to reflect the general state of the art within the profession.

Participant results are reported using a randomly assigned "WebCode". This code maintains participant's anonymity, provides linking of the various report sections, and will change with every report.

Manufacturer's Information

Each sample pack contained one known paint chip sample and two sets of questioned paint chips. Participants were asked to examine the questioned paint chips and determine if either could have originated from the same known paint chip sample.

SAMPLE PREPARATION: The substrate panels used for this test were inspected for defects, and the areas containing defects were not used. Association items were selected at the same time and within close spatial proximity to one another prior to item packaging and maintained together as association batches during sample pack assembly.

KNOWN ITEMS: One paint chip sample, approximately 1/2" x 1/2" in size, was selected and deposited into a glassine bag and then placed into a pre-labeled item envelope and sealed.

QUESTIONED ITEMS: Two paint chip samplings, approximately 1/4" x 1/4" in size, were selected and deposited into a glassine bag and then placed into a pre-labeled item envelope and sealed.

SAMPLE PACK ASSEMBLY: All items were placed into a pre-labeled sample pack envelope and sealed. This process was repeated until all of the sample packs were prepared.

VERIFICATION: Predistribution results were consistent with each other and the manufacturer's preparation information. The following procedures were used to examine the items: Stereomicroscopy, Polarized Light Microscopy, Fluorescence, Pyrolysis GC, Solubility/Chemical Examination, XRS/XRF, FTIR, and SEM/EDX.

Item	Known/ Questioned	Association/ Elimination	Automotive Substrate	Primer	Color	Clear Coat
1	Known	Association	Grey-Coated Aluminum Coil Panel	U338AW400	E211AW018 (Metallic Silver)	E10CG500D
2	Questioned	Association	Grey-Coated Aluminum Coil Panel	U338AW400	E211AW018 (Metallic Silver)	E10CG500D
3	Questioned	Elimination	Grey-Coated Aluminum Coil Panel	U338WW207	E211AW018 (Metallic Silver)	E10CG500D

Summary Comments

This test was designed to allow participants to assess their proficiency in the examination, comparison, and interpretation of multi-layered automotive paint samples. Items 1 and 2 were prepared from the same source of automotive paint panel. Item 3 was prepared from a different source of automotive paint panel. Refer to the Manufacturer's Information for preparation details.

Of the 69 responding participants, 62 (90%) identified Item 2 and eliminated Item 3 as having originated from the Item 1 known paint sample. Of the remaining seven participants, three participants identified both Items 2 and 3 as having originated from the Item 1 known paint sample, two participants eliminated Item 2 and identified Item 3 as having originated from the Item 1 known paint sample, and two participants either eliminated or were inconclusive for Item 2 and eliminated Item 3 as having originated from the Item 1 known paint sample.

The most commonly reported examination procedures included: FTIR (97%), Stereomicroscopy (96%), and SEM/EDX (46%).

Examination Results

Could either of the questioned paint chips recovered from the crime scene (Item 2 and Item 3) have originated from the damaged area of the suspect's vehicle as represented by Item 1?

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
366W27	Yes	No	EAEDW4	Yes	No
3DVJQG	No	No	EDVLJ3	Yes	No
3JZFC3	Yes	No	EFGHRU	Yes	No
3TCHVH	Yes	No	EQY4V3	Yes	No
3WBTRH	Yes	No	ERFZM3	Yes	No
6EJUEF	Yes	No	EWPGWQ	Yes	No
6K8DZ4	Yes	No	GUW696	Yes	No
6UTHQF	Yes	No	HJ8V2M	Yes	No
7BELMA	Yes	No	J6P8P4	Yes	No
7N4KFX	Yes	No	JA33CT	Yes	No
8NFKA8	Yes	No	JZAZ26	Yes	No
8RJFUA	Yes	No	K4QJLY	Yes	No
8X9RVX	No	Yes	KHKR28	Yes	No
9DR6KA	Yes	No	KYWPNX	Yes	No
9W98K4	Yes	No	LE44JZ	Yes	No
A7CL3V	Inc	No	LFE4LL	Yes	No
ANRV4W	Yes	Yes	LJDEGL	Yes	No
ART487	Yes	No	M6T2XZ	Yes	Yes
BARFF8	Yes	No	MJTZKW	Yes	Yes
BKPGTC	Yes	No	NDYKBF	Yes	No
BLGF8A	Yes	No	NQAV2Q	Yes	No
C3MYKR	Yes	No	P4T3DH	Yes	No
CJRLPZ	Yes	No	P97LUY	Yes	No
CK6ZD9	Yes	No	PAJDMF	Yes	No
CTCWYR	Yes	No	QHT22E	No	Yes

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
RFW6PP	Yes	No			
T2FAAT	Yes	No			
T6TA7K	Yes	No			
T9RNTB	Yes	No			
TWZ2LU	Yes	No			
TZ4TWF	Yes	No			
UF7U3M	Yes	No			
UMPWAP	Yes	No			
VGKFEA	Yes	No			
VHD9AT	Yes	No			
VPB2HL	Yes	No			
VUFNRW	Yes	No			
WP8ZVR	Yes	No			
XE46CM	Yes	No			
XKTHDA	Yes	No			
XNTTAA	Yes	No			
YGPAN	Yes	No			
ZAJFNN	Yes	No			
ZUA7YM	Yes	No			

Examination Response Summary			Participants: 69
<i>Could either of the questioned paint chips recovered from the crime scene (Item 2 and Item 3) have originated from the damaged area of the suspect's vehicle as represented by Item 1?</i>			
	<u>Item 2</u>	<u>Item 3</u>	
Yes:	65 (94.2%)	5 (7.2%)	
No:	3 (4.3%)	64 (92.8%)	
Inc:	1 (1.4%)	0 (0%)	

Examination Procedures

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility / Chemical	Microspectrophotometry	XRF / XRS	SEM / EDX	Other
366W27	✓				✓			✓		
3DVJQG	✓				✓		✓	✓		Raman
3JZFC3	✓	✓								
3TCHVH	✓				✓	✓				
3WBTRH	✓	✓			✓					
6EJUEF	✓	✓	✓		✓			✓		
6K8DZ4	✓				✓			✓		Raman Spectroscopy
6UTHQF	✓	✓	✓		✓					RAMAN microscopy
7BELMA	✓				✓					Raman spectroscopy, optical microscopy examination of paint cross sections
7N4KFX	✓			✓	✓			✓		PGC was with MS; SEM also with BSI
8NFKA8	✓	✓			✓		✓			
8RJFUA	✓				✓			✓		Raman spectroscopy (excitation source: 785 nm)
8X9RVX	✓				✓	✓				
9DR6KA	✓	✓	✓		✓					Raman
9W98K4	✓	✓		✓	✓			✓		
A7CL3V	✓				✓					ToolScan R360
ANRV4W	✓				✓					Physical examination
ART487	✓	✓			✓					
BARFF8	✓	✓			✓					microtomy

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility / Chemical	Microspectrophotometry	XRF / XRS	SEM / EDX	Other
BKPGTC	✓				✓					
BLGF8A	✓	✓	✓		✓	✓		✓		Raman spectroscopy, LA-ICP-MS
C3MYKR	✓				✓		✓			
CJRLPZ	✓	✓		✓	✓	✓			✓	
CK6ZD9	✓				✓	✓			✓	
CTCWYR	✓				✓	✓				
EAEDW4	✓	✓	✓		✓		✓		✓	
EDVLJ3	✓		✓		✓				✓	Raman spectroscopy
EFGHRU	✓	✓	✓		✓		✓			
EQY4V3	✓	✓	✓	✓	✓				✓	
ERFZM3	✓	✓	✓		✓		✓		✓	
EWPGWQ	✓				✓					
GUW696	✓				✓					
HJ8V2M	✓				✓					
J6P8P4	✓			✓	✓				✓	
JA33CT	✓	✓		✓	✓				✓	
JZAZ26	✓				✓					
K4QJLY	✓		✓		✓				✓	
KHKR28	✓	✓					✓			
KYWPNX	✓	✓	✓	✓	✓					

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility / Chemical	Microspectrophotometry	XRF / XRS	SEM / EDX	Other
LE44JZ	✓				✓	✓	✓			Raman (532, 638 and 785 nm)
LFE4LL	✓	✓		✓	✓				✓	
LJDEGL	✓		✓	✓	✓				✓	
M6T2XZ	✓		✓	✓	✓					
MJTZKW					✓	✓			✓	
NDYKBF	✓				✓				✓	
NQAV2Q	✓	✓	✓		✓				✓	
P4T3DH	✓				✓				✓	
P97LUY	✓				✓					
PAJDMF	✓				✓				✓	
QHT22E					✓				✓	
RFW6PP	✓	✓	✓		✓		✓			
T2FAAT	✓	✓	✓		✓	✓	✓	✓	✓	
T6TA7K	✓	✓	✓		✓				✓	
T9RNTB					✓					
TWZ2LU	✓				✓	✓				
TZ4TWF	✓	✓		✓	✓				✓	
UF7U3M	✓	✓			✓				✓	
UMPWAP	✓		✓		✓				✓	dark & bright field microscopy
VGKFEA	✓				✓				✓	Pyrolysis GCMS

TABLE 2

WebCode	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility / Chemical	Microspectrophotometry	XRF / XRS	SEM / EDX	Other
VHD9AT	✓				✓	✓				
VPB2HL	✓		✓		✓					
VUFNRW	✓				✓					
WP8ZVR	✓	✓			✓					
XE46CM	✓				✓	✓				
XKTHDA	✓				✓					Raman (785 nm)
XNTTAA	✓	✓	✓		✓			✓		
YGPAN	✓				✓					RAMAN MICROSCOPE, comparison microscope
ZAJFNN	✓				✓					
ZUA7YM	✓				✓					

Response Summary										Participants: 69
	Stereomicroscope	Polarized Light	Fluorescence	Pyrolysis GC	FTIR	Solubility/ Chemical	Microspectrophotometry	XRF/XRS	SEM/EDX	
Total	66	23	23	12	67	9	6	8	32	
Percent	96%	33%	33%	17%	97%	13%	9%	12%	46%	

Conclusions

TABLE 3

WebCode	Conclusions
366W27	The paint chips found in the suspect's vehicle (Item 1) and the questioned paint chips found at the crime scene (Items 2 and 3) were separated into a paint layer and a metal layer. The paint layer in contact with the metal layer was gray for Items 1 and 2, and white for Item 3. The analysis of the separated paint using FT-IR and SEM-EDS revealed that Items 1 and 2 had similar compositions. Therefore, it was determined that Item 2 originated from Item 1.
3DVJQG	The three items differ from each other in several key areas. The Top coat layer of Item 2 differs from that of Item 1 and Item 3 as seen in the peak complex located in the 1524-1380 cm ⁻¹ range as well as the presence of the peak at 1020 cm ⁻¹ in the IR spectrum of item 2. Further, a higher level of titanium dioxide is present in the pigment layer of Item 3 as seen by EDS. Additionally, the bottom most primer layer, called the sub-base coat, of Item 2 and 3 were found by EDS to contain a trace level of strontium that was not observed in the comparable layer of item 1. Based on the data the three paint chips appear to not share a similar source.
3JZFC3	The paint chips from item 2 cannot be distinguished from the paint chips coming from the damaged area of the suspect's vehicle. This concerns three coats: the primer, the basecoat and the clearcoat. It is therefore possible that the paint chips from item 2 comes from the damaged area of the suspect's vehicle. The paint chips from item 3 can be distinguished from the paint chips coming from the damaged area of the suspect's vehicle. The difference in the primer is in visual light very clear. The clearcoat shows a weak differentiation in the fluorescent examination. The basecoat could not be distinguished with the performed examinations. It is not possible, that the paint chips from item 3 originate from the damaged area of the suspect's vehicle.
3TCHVH	On analysis, I found the questioned paint chips recovered from the crime scene (Item 2) was similar with the known paint sample representative of the damaged area of the suspect's vehicle (Item 1).
3WBTRH	In my opinion, the findings provide: 1. Very strong support for the proposition that the paint chips, item 2, recovered from the crime scene have originated from the damaged area of the suspect's car, represented by item 1. 2. Conclusive support for the proposition that the paint chips, item 3, recovered from the crime scene have not originated from the damaged area of the suspect's car, represented by item 1.
6EJUEF	The silver color automotive paint sample labeled questioned paint chips recovered from the crime scene, (item 2), is consistent in color, layer sequence, physical characteristics, chemical composition, and elemental composition as compared to the silver color automotive paint sample labeled known paint sample representative of the damaged area of the suspect's vehicle, (item 1). Level III association. The silver color automotive paint sample labeled questioned paint chips recovered from the crime scene, (item 3), displays a difference in the color of the first primer layer as compared to the silver color automotive paint sample labeled known paint sample representative of the damaged area of the suspect's vehicle, (item 1). Elimination.
6K8DZ4	Based on the examinations performed, the questioned paint chip recovered from the crime scene (Item 2) was similar in colour, layer sequence, chemical composition and elemental composition to the reference paint sample from the damaged area of the vehicle of interest (Item 1). Therefore, the paint chip recovered from the crime scene (labelled as item 2) could have come from the damaged area of the vehicle of interest (as represented by item 1) or from another source of vehicular paint that also has an indistinguishable paint layer sequence. Based on the examination performed, the questioned paint chip from the crime scene (Item 3) exhibited a chemically different layer sequence to the reference paint sample from the

TABLE 3

WebCode	Conclusions
	damaged area of the vehicle of interest (Item 1). Therefore, the paint chip recovered from the crime scene (Item 3) could not have come from the damaged area of the vehicle of interest (as represented by item 1).
6UTHQF	<p>The Item 1 is a multilayer automotive paint system sampled from the damaged area of the suspect's vehicle. A 7 um microtome cutting shows 4 layers which characterizing an automotive metallic part : a colorless clearcoat, a grey effect basecoat, a grey primer surfacer and a grey first primer. The Item 2 is a multilayer automotive paint system recovered from the crime scene. A 7 um microtome cutting shows 4 layers characterizing an automotive metallic part : a colorless clearcoat, a grey effect basecoat, a grey primer surfacer and grey first primer. And to finish, the item 3 is a multilayer automotive paint system recovered from the crime scene. A 7 um microtome cutting shows 4 layers characterising an automotive metallic part : a colorless clearcoat, a grey effect basecoat, a white primer surfacer and a grey first primer. A visual comparison of - those microtome cuttings shows that the item 1 is different from the item 3, and that the item 1 is indistinguishable from the item 2 ; - the surfaces under the optical microscope does not show any conclusive results with regards to the pigments. Our comparative analytical methods show that : - the FTIR spectra of the item 1 layers are indistinguishable from the ones of the items 2 and 3 ; - the RAMAN spectra of the basecoat and primer from item 1 are indistinguishable with the ones of item 2 ; - the RAMAN spectra of the primer from item 1 is different from the one of item 3, whereas the RAMAN spectra of the basecoat from item 1 is indistinguishable from the one of item 3. The results of our observations and of our analysis show that it is highly probable that the paint chip recovered from the crime scene (Item 2) has the same origin as the one sampled from the damaged area of the suspect's vehicle (Item1). It is hence probable that a contact happened between the damaged area of the suspect's vehicle (item 1) and the place at the crime scene where Item 2 was recovered from.</p>
7BELMA	<p>Considering the number and color of layers, no significant visual differences were observed between Item 1 and Item 2. The analysis performed by FTIR and Raman spectroscopy determined that both samples are indistinguishable with the techniques used. Therefore, Item 1 and Item 2 could have the same origin.</p>
7N4KFX	<p>Results of Examinations: The Item 2 questioned paint chips recovered from the crime scene and the Item 3 questioned paint chips recovered from the crime scene were examined and compared to the Item 1 known paint representative of the damaged area of the suspect's vehicle. Based on the examinations conducted, the five layers of paint comprising Item 2 could not be distinguished in sequence, color, texture, and chemical composition to the corresponding layers of paint in Item 1. Accordingly, Item 1 and Item 2 originated from the same vehicle or from different vehicles painted in the same manner (Type III Association – see Interpretation section). This type of association was reached because, while many vehicles have paint systems different than these, other vehicles produced at the same manufacturing plant as the source of Item 1, which were painted with the same color and paint formulations, would also be indistinguishable. Item 1 and Item 3 differed in layer structure. Therefore, Item 1 and Item 3 do not share a common source (Elimination). Interpretation: The following categories and their descriptions are meant to provide context to the conclusions reached in this report. Every category may not be applicable in every case nor for every material. Type I Association: Physical Fit – The items exhibit physical features that demonstrate they were once part of the same object. Associations of Evidence with Class Characteristics: Class characteristics are physical and/or chemical properties that place an item within a particular group of items. Associations of evidence with class characteristics can have varying degrees of significance. In general, the smaller the size of the group relative to the relevant population, the more significant the association. A class association cannot definitively establish that the items came</p>

TABLE 3

WebCode	Conclusions
	<p>from the same source. Type II: Association with Highly Discriminating Characteristics – An association in which items could not be differentiated. Therefore, the possibility that the items came from the same source cannot be eliminated. Additionally, the items share unusual characteristics that would not be expected to be encountered in the relevant population. Type III: Association with Discriminating Characteristics – An association in which items could not be differentiated. Therefore, the possibility that the items came from the same source cannot be eliminated. Other items have been manufactured that would also be indistinguishable from the submitted items and could be encountered in the relevant population. Type IV: Association with Limitations – An association in which items could not be differentiated. Therefore, the possibility that the items came from the same source cannot be eliminated. As compared to the categories above, this type of association has decreased evidential value. For example, the items are more commonly encountered in the relevant population, a complete analysis was not performed due to limited characteristics or a limited analytical scheme, or minor variations were observed in the data. Inconclusive – No conclusion could be reached. Elimination – The items exhibit exclusionary differences that demonstrate they did not originate from the same source.</p>
8NFKA8	<p>The paint samples submitted in Exhibits 1, 2, and 3 were examined visually and with the aid of a stereomicroscope to evaluate layer structure and visual appearance. In addition to Exhibits 1 – 3 each being on a metal substrate, the following observations were made: Exhibit 1 has the following layer structure: clear / metallic silver / light gray / dark gray; Exhibit 2 has the following layer structure: clear / metallic silver / light gray / dark gray; Exhibit 3 has the following layer structure: clear / metallic silver / white / dark gray. The chemical compositions of each paint layer in Exhibits 1 – 3 were assessed using Fourier-Transform Infrared Spectroscopy (FTIR) and the pigmented layers were further examined using X-ray Fluorescence Spectroscopy (XRF) to assess elemental composition. The light gray layer of Exhibits 1 – 2 and the white layer of Exhibit 3 were further analyzed using Polarizing Light Microscopy (PLM). No exclusionary differences were detected between the corresponding layers of Exhibits 1 and 2 by FTIR and XRF. Additionally, the light gray layers were not differentiated by PLM. Therefore, the vehicle represented by Exhibit 1, or another damaged vehicle with an applied paint system with all the same visual, chemical, and elemental characteristics, could be the source of the paint collected at the scene of the Exhibit 2 paint chips. The clear, metallic silver, and dark gray layers of Exhibit 3 cannot be differentiated from the corresponding layers of Exhibit 1 by FTIR or XRF. However, visually and by PLM the white layer of Exhibit 3 is differentiated from the light gray layer of Exhibit 1, as represented by the standard received. While there are layers with shared characteristics, based on the standard received, Exhibit 1 is not the source of the Exhibit 3 paint chips left at the scene.</p>
8RJFUA	<p>Questioned paint chips recovered from the crime scene (Item 2) could have originated from the damaged area of suspect's vehicle (Item 1). Questioned paint chips recovered from the crime scene (Item 3) could not have originated from the damaged area of suspect's vehicle (Item 1).</p>
8X9RVX	<p>On analysis, I found that Item 3 is similar to Item 1. Hence, I am of the opinion that the questioned paint chips recovered from the crime scene (Item 3) could have originated from the known paint sample representative of the damaged area of the suspect's vehicle (Item 1).</p>
9DR6KA	<p>The questioned paint chips in Item 2 are similar to the known paint in Item 1 regarding the physical and chemical properties of the paint layers. The questioned paint chips in Item 3 are different from the known paint in Item 1 regarding the physical and chemical properties of the paint layers.</p>
9W98K4	<p>1. Comparative examinations of Exhibit 2 (questioned paint chips recovered from the crime scene) with the paint from Exhibit 1 (known paint sample representative of the damaged area of suspect's vehicle) disclosed them to be consistent in their physical characteristics, organic</p>

TABLE 3

WebCode	Conclusions
	<p>compositions, and elemental compositions. Therefore, Exhibit 2 could have originated from Exhibit 1 or another source with the same characteristics. 2. Comparative examinations of Exhibit 3 (questioned paint chips recovered from the crime scene) with the paint from Exhibit 1 (known paint sample representative of the damaged area of suspect's vehicle) disclosed them to be inconsistent in their physical characteristics. Therefore, Exhibit 3 could not have originated from Exhibit 1. 3. It should be noted that a paint association is not a means of positive identification and the number of possible sources for a specific paint is unknown.</p>
A7CL3V	<p>Examination of questioned Item 2 and known Item 1 revealed both paint chips with the following four (4) layer structures: clearcoat, basecoat, primer surfacer and electrocoat primer applied to a metal substrate. The questioned paint chips recovered from the crime scene (Item 2) were found to be consistent with respect to colour of all layers, thickness of paint layers, chemical compositions of clearcoat and paint layer structure to the known paint sample representative of the damaged area of the suspect's vehicle (Item 1). Examination of questioned Item 3 and known Item 1 revealed both paint chips with the following four (4) layer structures: clearcoat, basecoat, primer surfacer and electrocoat primer applied to a metal substrate. The questioned paint chips recovered from the crime scene (Item 3) were found to be consistent with respect to colour of clearcoat, basecoat and electrocoat primer layers, thickness of paint layers, chemical composition of clearcoat and paint layer structure to the known paint sample representative of the damaged area of the suspect's vehicle (Item 1). The colour of the primer surfacer layer of questioned Item 3 was found to be inconsistent to that of known Item 1. Based on the above finding, in my opinion, (a) Examination of the known paint representative of the damaged area of the suspect's vehicle (Item 1) was found to be physically and chemically consistent to the questioned paint chips from Item 2. However, no examination was conducted to identify the chemical composition of basecoat, primer surfacer and electrocoat primer layers. Therefore, no conclusion could be reached as to whether or not Item 2 could have originated from the damaged area of the suspect's vehicle as represented by Item 1. (b) Examination of the known paint representative of the damaged area of the suspect's vehicle (Item 1) was found to be physically inconsistent to the questioned paint chips from Item 3. Therefore, Item 3 could not have originated from the damaged area of the suspect's vehicle as represented by Item 1.</p>
ANRV4W	<p>It has been determined that Item 1, Item 2 and Item 3 are physically and chemically similar.</p>
ART487	<p>The examined portions of the questioned paint recovered from the crime scene (Item 1-2) were found to be consistent in microscopic appearance and instrumental properties with the examined portions of the known paint sample representative of the damaged area of the suspect's vehicle (Item 1-1). Accordingly, the examined portions of Item 1-2 could have originated from the examined portions of Item 1-1 or from another source with similar characteristics. The examined portions of the questioned paint recovered from the crime scene (Item 1-3) were found to be different in microscopic appearance from the examined portions of the known paint sample representative of the damaged area of the suspect's vehicle (Item 1-1). Accordingly, the examined portions of Item 1-3 could not have originated from the examined portions of Item 1-1.</p>
BARFF8	<p>The known paint sample from the damaged area of the suspect's vehicle (item 1) was a silver-effect paint which included the following paint layer-sequence; lacquer/ silver-effect/ grey/ dark grey/ light grey on a metal substrate. The recovered paint sample from the crime scene (item 2) was a silver-effect paint which included the following paint-layer sequence; lacquer/silver-effect/grey/dark grey/light grey, which matched in microscopic appearance and layer-sequence the known paint (item 1) from the suspect's vehicle. The chemical composition of the corresponding lacquer, silver-effect, grey and dark grey layers also matched. The recovered paint from the scene (item 2) matches the known paint from the suspect's vehicle</p>

TABLE 3

WebCode	Conclusions
	(item 1) with respect to microscopic appearance, layer sequence and chemical composition, therefore could have originated from the damaged area of the suspect's vehicle. The recovered paint sample from the crime scene (item 3) was a silver-effect paint which included the following paint-layer sequence; lacquer/silver-effect/white/dark grey/light grey which did not match the known paint (item 1) from the suspect's vehicle with respect to microscopic appearance and layer-sequence. The recovered paint from the scene (item 3) does not match the known paint from the suspect's vehicle (item 1), therefore could not have originated from the damaged area of the suspect's vehicle.
BKPGTC	Paint chips recovered from the crime scene (Item 2) may come from the suspect's vehicle (Item 1).
BLGF8A	Item 2 paint chip, recovered from the crime scene could have originated from the damaged area of the suspect's vehicle as represented by Item 1. Item 3 paint chip, recovered from the crime scene could not have originated from the damaged area of the suspect's vehicle as represented by Item 1.
C3MYKR	Item 2 is indistinguishable from item 1 in physical and chemical proprieties. Therefore, item 2 (Questioned paint chips recovered from the crime scene) could have originated from item 1 (Known paint sample representative of the damaged area of the suspect's vehicle). Item 3 is distinguishable from item 1 in physical proprieties. Therefore, item 3 (Questioned paint chips recovered from the crime scene) did not originate from item 1 (Known paint sample representative of the damaged area of the suspect's vehicle).
CJRLPZ	<p>CONCLUSIONS: The questioned paint identified as recovered from the scene (item 2) is the same distinct type of paint as the known paint from the suspect's vehicle (item 1) and originated either from that source or another source of automotive paint having the same distinct characteristics. The questioned paint identified as recovered from the scene (item 3) did not originate from the suspect's vehicle represented by item 1. RESULTS: Questioned paint chips identified as recovered from the scene (items 2 and 3) were examined for the purpose of determining whether or not they are like the known paint identified as from the suspect's vehicle (item 1). The paint standard from the suspect's vehicle (item 1) has the following layer structure: 1. Colorless acrylic-urethane enamel clearcoat. 2. Colorless acrylic-urethane-melamine enamel basecoat with effect pigment. 3. Medium gray polyester-melamine enamel primer. 4. Dark gray polyester-melamine enamel primer. 5. Metal substrate. This paint exhibits characteristics typical of an original automotive finish and was used for comparison with questioned paint identified as recovered from the scene (items 2 and 3). Examination and comparison of the questioned paint (item 2) with item 1 revealed they are alike with respect to layer structure, layer colors, layer textures, microchemical reactivities, binder characteristics, and pigment characteristics. It is therefore concluded that the questioned paint identified as recovered from the scene (item 2) is the same distinct type of paint as that on the suspect's vehicle (item 1) and originated either from that vehicle, or from another source of automotive paint having the same distinct characteristics. The questioned paint from the scene (item 3) has the following layer structure: 1. Colorless clearcoat. 2. Colorless basecoat with effect pigment. 3. White primer. 4. Dark gray primer. 5. Metal substrate. Examination and comparison of the questioned paint identified as from the scene (item 3) with item 1 revealed layer 3 is dissimilar with respect to color. It is therefore concluded that the questioned paint identified as recovered from the scene (item 3) did not originate from the area of the suspect's vehicle represented by item 1. METHODS OF ANALYSIS: Examinations were performed visually, by stereo microscopy, brightfield/polarized light comparison microscopy, microchemical tests, Fourier transform infrared microspectroscopy, pyrolysis gas chromatography, and scanning electron microscopy/energy dispersive x-ray analysis.</p>

TABLE 3

WebCode	Conclusions
CK6ZD9	<p>On analysis, I found: i)The known paint sample representative of the damaged area of the suspect's vehicle (Item 1) to be similar to the questioned paint chips recovered from the crime scene (Item 2). ii)The known paint sample representative of the damaged area of the suspect's vehicle (Item 1) to be dissimilar to the questioned paint chips recovered from the crime scene (Item 3). Based on findings, I am of the opinion that: i)The known paint sample representative of the damaged area of the suspect's vehicle (Item 1) and the questioned paint chips recovered from the crime scene (Item 2) could have come from the same source. ii)The known paint sample representative of the damaged area of the suspect's vehicle (Item 1) and the questioned paint chips recovered from the crime scene (Item 3) did not come from the same source.</p>
CTCWYR	[No Conclusions Reported.]
EAEDW4	<p>Item 1 consists of a three-layered paint sample adhering to a metal substrate. The top layer (Layer 1) is clear and colorless with reflective, silver-colored flakes in the lower portion. The second layer (Layer 2) is light gray. The bottom layer adjacent to the metal substrate (Layer 3) is dark gray. Item 2 consists of two paint chips designated 2A and 2B that appear indistinguishable. Item 2A is a three-layered paint sample adhering to a metal substrate. The top layer (Layer 1) is clear and colorless with reflective, silver-colored flakes in the lower portion. The second layer (Layer 2) is light gray. The bottom layer adjacent to the metal substrate (Layer 3) is dark gray. Item 2A is similar in color, layer structure, microscopic characteristics, and chemical composition to item 1; therefore, item 2A could have originated from item 1 or another paint source with the same class characteristics. Item 3 consists of two paint chips designated 3A and 3B that appear indistinguishable. Item 3A is a three-layered paint sample adhering to a metal substrate. The top layer (Layer 1) is clear and colorless with reflective, silver-colored flakes in the lower portion. The second layer (Layer 2) is white. The bottom layer adjacent to the metal substrate (Layer 3) is dark gray. Item 3A is dissimilar in layer color and thickness in comparison to item 1; therefore, item 3A could not have originated from item 1.</p>
EDVLJ3	<p>Based on visual observations with (stereo)microscopy and the analytical results from infrared spectroscopy and SEM/EDX ITEM 3 can be distinguished from ITEM 1. These results support the proposition that these paint chips (ITEM 3) recovered from the crime scene originate from an unknown vehicle rather than that these traces originate from the suspect's vehicle (ITEM 1). Based on visual observations with (stereo)microscopy and the analytical results from infrared spectroscopy, Raman spectroscopy and SEM/EDX ITEM 2 cannot be distinguished from ITEM 1. These results support the proposition that these paint chips (ITEM 2) recovered from the crime scene originate from the suspect's vehicle (ITEM 1) rather than that these traces originate from an unknown vehicle.</p>
EFGHRU	<p>No differences were observed in macroscopic, microscopic, chemical or elemental characteristics between Items 1 and 2. These two paint samples could have originated from the same source. No differences were observed in chemical and elemental characteristics between Items 1 and 3, but there is a significant difference in color with the base layers. These two paint samples did not originate from the same source.</p>
EQY4V3	<p>Item 1 compared to Item 2: Items 1 and 2 were found to be indistinguishable from one another. Based on the analyses performed, items 1 and 2 are the same distinct type of paint with respect to their layer structure, appearance, and chemical composition. Item 2 could have originated from item 1 or another source of paint having the same characteristics. Item 1 compared to Item 3: Item 1 and 3 differed in physical characteristics (number of layers/layer structure) and in elemental composition. Item 1 is eliminated as a possible source of item 3.</p>
ERFZM3	<p>Examination and comparison of the Item 2 questioned paint with Item 1 revealed they are</p>

TABLE 3

WebCode	Conclusions
	<p>consistent with respect to their observed and measured physical and chemical properties of layer sequence and the chemical composition of corresponding layers when analyzed using PLM, FTIR, SEM/EDS, and MSP. It is therefore concluded that the Item 2 questioned paint recovered from the crime scene corresponds to the Item 1 paint and therefore originated either from that vehicle or from another source of automotive paint having the same distinct characteristics. (Association with Discriminating Characteristics). Examination and comparison of the Item 3 questioned paint with Item 1 revealed they are different with respect to color and the chemical composition of one of the primer layers. It is therefore concluded that this questioned paint recovered from the crime scene did not originate from the damaged area of the suspect's vehicle represented by known sample Item 1. (Elimination)</p>
EWPGWQ	[No Conclusions Reported.]
GUW696	<p>1. The paint in Exhibit 2 originated either from the source of the paint in Exhibit 1 or from another source of physically and chemically indistinguishable paint. 2. The paint in Exhibit 3 did not originate from the source of the paint in Exhibit 1.</p>
HJ8V2M	<p>1) Microscopic Examination. Item 1 and Item 2 are indistinguishable in appearance, whereas both items have layers of transparent plastic, silver, grey, and dark grey. So, Item 1 and Item 2 are similar in color, texture and layering. Item 3, on the other hand, has transparent plastic, silver, white, and dark grey. So, Item 1 and Item 3 are similar in color and texture, but has different layering. 2) FTIR Analysis. Item 1 and Item 2 are similar in composition, while Item 3 and Item 1 differ. Hence, it was found that Item 2 is similar to Item 1 and could have originated from Item 1. It was also found that Item 3 is not similar to Item 1 and could not have originated from Item 1.</p>
J6P8P4	<p>After microscopic inspection and composition analysis, Item 2 and Item 1 were found to be similar. The white layer in Item 3, however, does not match the gray layer in Item 1 in color, which suggests it is unlikely to originate from Item 1.</p>
JA33CT	<p>1. Comparative examinations of Exhibit 2 (item 2) with Exhibit 1 (item 1) disclosed them to be consistent in their physical characteristics, organic compositions, and elemental compositions. As a result of these findings, Exhibit 2 could have originated from Exhibit 1, or another source with the same characteristics. A paint association is not a means of positive identification and the number of possible sources for a specific paint is unknown. 2. Comparative examinations of Exhibit 3 (item 3) with Exhibit 1 (item 1) disclosed them to be inconsistent in their physical characteristics. As a result of these findings, Exhibit 3 could not have originated from Exhibit 1.</p>
JZAZ26	<p>1) The know paint sample representative of the damage area of the suspect's vehicle (item 1), the questioned paint chips recovered from the crime scene (item 2), consist to four layers paint system with the following layer structure: 1. clear coat iso polyester-melamine modified with urethane with talc, 2. lighth grey pearlescent iso polyester-melamine modified with urethane, 3. lighth gray iso polyester-melamine modified with urethane and 4 dark gray tere polyester-melamine with talc and barium sulfate. 2) The questioned paint chips recovered from the crime scene (item 3), consist to five layers paint system with the following layer structure: 1. clear coat iso polyester-melamine modified with urethane with talc, 2. lighth grey pearlescent iso polyester-melamine modified with urethane, 3. lighth gray iso polyester-melamine modified with urethane, 4 dark gray tere polyester-melamine with talc and barium sulfate and 5. gray-green tere polyester-melamine modified with urethane with calcium carbonate and chine clay. 3) The four layered paint chips in items 1 and 2 matches in all properties investigated, particularly in colors, textures, types, layer sequence and chemical composition. This indicates that both signs could share a common origin (see additional comments). 4) The know paint sample representative of the damage area of the suspect's vehicle (item 1) and the questioned paint chips recovered from crime scene (item 3), presents similar macroscopic, microscopic and</p>

TABLE 3

WebCode	Conclusions
	physical characteristics, particularly in four layers, however, the presence of a gray-green inner layer which is absent in the fragment of item1, does not allow them to associate with each other.
K4QJLY	The sample from the crime scene (item 2) was found to be similar in colour, layer sequence, chemical properties and composition to the paint from the damaged vehicle (item 1) such that in our opinion, it provides moderate support that they had a common origin. The sample from the crime scene (item 3) was found to be different in layer sequence from the damaged vehicle (item 1) such that in our opinion, they did not come from the same source.
KHKR28	Based on the stereomicroscope images, there is virtually no difference between any of the samples. All paint chips appear consistent with one another on top, bottom, and cross sections. However, when the paint chips were sectioned using a scalpel, there was a clear similarity between Item 1 and Item 2 in that the undersides of both paint scrapings were gray. The underside of the scraping taken from Item 3 was white. These differences/similarities were additionally imaged using the polarized light microscope. XRF confirmed that the elemental composition of Item 2 is consistent with that of Item 1 and that Item 3 is not elementally consistent with Item 1, thereby concluding that the questioned paint chip (Item 2) could have originated from the suspect's car as represented by Item 1.
KYWPNX	01-01-AA: Known paint standard from the damaged area of the suspect's vehicle (Item 1) This item was used for comparison purposes. 01-02-AA: Glassine envelope ("paint chips recovered from the crime scene") (Item 2) Two paint chips were observed within this item. The questioned paint chips are similar in visual color to the known paint from the damaged area of the suspect's vehicle (01-01-AA). One of these paint chips was selected for further analysis and is similar in layer sequence, fluorescence, paint type, and paint composition to the known paint from the damaged area of the suspect's vehicle. It is my opinion that the questioned paint could have come from the damaged area of the suspect's vehicle or any other vehicle with similar paint characteristics (Category 2B). No analysis was done on the remaining paint chip. No further analysis done. 01-03-AA: Glassine envelope ("paint chips recovered from the crime scene") (Item 3) Two paint chips were observed within this item. The questioned paint chips are similar in visual color to the known paint from the damaged area of the suspect's vehicle (01-01-AA). One of these paint chips was selected for further analysis and is dissimilar in layer sequence to the known paint from the damaged area of the suspect's vehicle. It is my opinion that the questioned paint could not have come from the damaged area of the suspect's vehicle (Category 5). No analysis was done on the remaining paint chip. No further analysis done. Investigative Leads and Requirements for Further Analysis: If additional trace evidence analysis is necessary, please contact this analyst. Disposition: The evidence will be retained until the laboratory is notified of the disposition.
LE44JZ	A visual inspection of the samples revealed no discernible difference between Item 1 and Item 2, either in the colour of the individual layers or in the overall position and number of layers of the paint chips. The findings were further endorsed through the utilisation of analytical techniques, namely FT-IR, Raman and XRF, which collectively indicated that Item 2 could originate from the damaged area of the suspect's damaged vehicle (Item 1). A visual difference was initially identified in the third consecutive layer of Item 3 (white coloured layer) in comparison to the third consecutive layer of Item 1 and Item 2 (grey coloured layer). Subsequent Raman and XRF analysis of the third layer provided additional proof of a difference between Item 1 and Item 3. We found no difference to the other corresponding layers on the paint chips.
LFE4LL	The vehicle, as represented by item 1, could not be eliminated as a possible source of the paint chips recovered from the scene, item 2. As such, the paint recovered from the scene (item 2) either came from the vehicle (as represented by item 1) or from another source of paint that

TABLE 3

WebCode	Conclusions
	is indistinguishable from item 1 with respect to the properties listed in the results. Other sources of indistinguishable paint would include other damaged items painted with the same manufacturer's formulations and colours. The vehicle, as represented by item 1, was eliminated as a possible source of the paint chips recovered from the scene, item 3.
LJDEGL	I have considered the following propositions to evaluate my findings: 1. Questioned paint chips, Item 2 and/or Item 3, recovered from the crime scene originated from the damaged area of the suspect's vehicle. 2. Questioned paint chips, Item 2 and/or Item 3, recovered from the crime scene are from an unrelated source. In relation to the questioned Item 2 and known Item 1, I consider the findings to be more probable if the first proposition is true, that is, Item 2 originated from the damaged area of the suspect's vehicle, Item 1, rather than from an unrelated source. In relation to questioned Item 3 and known Item 1, I consider the findings to be more probable if the second proposition is true, that is, Item 3 did not originate from the damaged area of the suspect's vehicle, Item 1, but originated from an unrelated source. Consequently, it is my opinion that the findings provide moderate support for the proposition that paint recovered from the crime scene (Item 2) originated from the suspect's vehicle, Item 1. The recovered paint from the crime scene (Item 3) can be excluded from having originated from the suspect's vehicle, Item 1, based on differences observed in the analysis.
M6T2XZ	The Questioned paint chips recovered from the crime scene (Item 3) could have originated from the damaged area of the suspect's vehicle (Item 1), because of the similarities of their physical properties and chemical compositions. The Questioned paint chips recovered from the crime scene (Item 2) could have originated from the damaged area of the suspect's vehicle (Item 1), because of the similarities of their physical properties and chemical compositions.
MJTZKW	Visually the three samples were indistinguishable, very similar silver colors with flakes of a metallic appearance. Diagonal cuts revealed four distinct layers consistent with an automotive coating: clearcoat, metalized topcoat / base coat, dark primer layer and a yellowish E-coat. FTIR and EDX spectra of the four layers were generally indistinguishable between Items 1, 2 and 3. Metalized layers were composed of aluminum flakes in all three samples.
NDYKBF	It was determined that Item-1 and Item-2 were similar in terms of physical and chemical properties. It was determined that Item-1 and Item-3 were different in terms of physical properties.
NQAV2Q	Item 1: One five-layer metallic silver paint standard was analyzed for comparison to Items 2 and 3. Item 2: Two five-layer metallic silver paint chips were found. In the sample analyzed, the unknown paint and the standard paint (Item 1) are the same in physical and chemical characteristics. The unknown paint either originated from the standard from the "suspect's vehicle" or another source of paint possessing the same distinct physical and chemical characteristics. Item 3: Two five-layer metallic silver paint chips were found. In the sample analyzed, the unknown paint and the standard paint (Item 1) are not the same in physical characteristics. The unknown paint could not have originated from the standard.
P4T3DH	It was determined that item-1 and item-2 were similar in terms of physical and chemical properties. it was determined item-1 and item-3 were different in terms of physical properties.
P97LUY	1) The known paint sample representative of the damaged area of the suspect's vehicle (item 1) and the questioned paint chips recovered from the crime scene (item 2 and item 3) consist of a five layers paint system with the following layer structure: Item 1 and Item 2: Colorless styrene modified acrylic-urethane enamel clear coat, 2. Silver grey with decorative flakes urethane modified isophthalic-polyester-melamine enamel base coat, 3. Gray isophthalic-polyester- melamine enamel primer, 4. Dark gray terephthalic-polyester-melamine enamel primer, and 5. Light green urethane modified terephthalic-polyester-melamine enamel primer. Item 3: Colorless styrene modified acrylic-urethane enamel clear coat, 2. Silver grey with

TABLE 3

WebCode	Conclusions
	decorative flakes urethane modified isophthalic -polyester- melamine enamel base coat, 3. White isophthalic-polyester-melamine enamel primer, 4. Dark gray terephthalic- polyester-melamine enamel primer, and 5. Light green urethane modified terephthalic-polyester-melamine enamel primer. 2) The five layered paint samples in items 1 and 2 match in colors, textures and chemical composition. It is concluded that these fragments may come from the same vehicle, or from another vehicle that specifically has the same original five-layer finish (same layer sequence, physical properties and chemical composition) and the same type of damage caused by the event under investigation. 3) The paint chips in item 1 and 3 match in the physical and chemical properties studied of the clear coat, base coat, and the innermost layers 4 and 5, but don't match in the physical properties of layer 3. It was concluded that the paint in these items don't have a common origin.
PAJDMF	Item 2 could have originated from item 1 Item 3 could not have originated from item 1
QHT22E	Based on FTIR analysis of the top layer of paint of all three items, neither Item 2 nor Item 3 (questioned paint chips recovered from the crime scene) could be excluded as having originated from Item 1 (suspect's vehicle). In addition, SEM and EDS analysis of all four layers in Items 1 and 3 did not detect any significant variations between them, therefore it was concluded that Item 3 (questioned paint chips recovered from the crime scene), could have originated from Item 1 (suspect's vehicle). However, a comparison between SEM and EDS analysis results for Items 1 and 2 did reveal a difference in texture and elemental composition within the second layer down. Therefore, it was concluded that Item 2 (questioned paint chips recovered from the crime scene) could not have originated from Item 1 (suspect's car).
RFW6PP	Items 1 and 2 are similar in all examined characteristics. Therefore, the paint chips from item 2 could have originated from the vehicle represented by item 1 or another source of automotive paint with these same characteristics. One of the primer layers from item 3 differs from item 1 in color, thickness, and relative pigment distribution. Therefore, the paint chips from item 3 could not have originated from the vehicle represented by item 1.
T2FAAT	It has been determined that the paint samples numbered 1 are physically and chemically SIMILAR to the paint samples numbered 2. It has been determined that the paint samples numbered 1 are physically and chemically DIFFERENT from the paint samples numbered 3.
T6TA7K	The Item 1 silver paint chip is a five-layer automotive paint composed of a clear layer, silver metallic layer, light gray primer, dark gray primer, and white gray primer. The Item 2 silver paint chips are composed of a five-layer automotive paint composed of a clear layer, silver metallic layer, light gray primer, dark gray primer, and white gray primer. The Item 3 silver paint chips are composed of a five-layer automotive paint composed of a clear layer, silver metallic layer, white primer, dark gray primer, and white gray primer. The Item 1 silver paint chip was compared to the Item 2 silver paint chips. The Item 1 silver paint chip is similar in microscopical characteristics and chemical composition to the Item 2 silver paint chips. Therefore, the Item 1 silver paint chip from the same source as the Item 2 silver paint chips or any other source with the same microscopical characteristics and chemical composition. This is a Type 3 Association as described in the Association Scale included in this report. The Item 1 silver paint chip was compared to the Item 3 silver paint chips. The Item 1 silver paint chip is different in color from the Item 3 silver paint chip. This is an Exclusion as described in the Association Scale included in this report. [Association Scale was not included with Report.]
T9RNTB	Item 1 and Item 2 have the same feature. Item 3 was evaluated to be different
TWZ2LU	Item 2 (the questioned paint chips recovered from the scene) may have had a common origin with Item 1 (known paint samples representative of the damaged area of the suspect's vehicle). Item 3 (the questioned paint chips recovered from the scene) did not have a common origin

TABLE 3

WebCode	Conclusions
TZ4TWF	<p>with Item 1 (known paint samples representative of the damaged area of the suspect's vehicle).</p> <p>Examinations and comparisons were performed in order to determine whether or not there is evidence of an association between the suspect's vehicle and the crime scene. Standard Sample - Item 1 Item 1, which was collected from the damaged area of the suspect's vehicle contains one (1) paint chip which has the following layer structure: 1. Clear colorless acrylic-styrene-urethane topcoat 2. Silver polyester-melamine-urethane metallic finishcoat 3. Light gray polyester- melamine undercoat 4. Dark gray alkyd-melamine-polyester primer 5. Thin medium yellow-gray primer - Apparent metal substrate This paint chip exhibits characteristics consistent with an original automotive paint layer system and it was used as a standard sample representative of the damaged area of the suspect's vehicle. Questioned Samples – Items 2 and 3 Item 2, which was recovered from the crime scene, contains two (2) paint chips which have the following layer structure: 1. Clear colorless acrylic-styrene-urethane topcoat 2. Silver polyester-melamine-urethane metallic finishcoat 3. Light gray polyester-melamine undercoat 4. Dark gray alkyd-melamine-polyester primer 5. Thin medium yellow-gray primer - Apparent metal substrate Microscopical examinations and comparisons between these Item 2 paint chips and the standard paint sample in Item 1 revealed that they are alike with respect to layer colors, layer textures and layer sequence of the respective layers. Further instrumental examinations and comparisons revealed that Layers 1-4 are also alike with respect to binder types, detailed binder characteristics, pigment characteristics and elemental characteristics of the respective layers. It is therefore concluded that the Item 2 paint chips from the crime scene could have originated from the damaged area of the suspect's vehicle. Item 3, which was also recovered from the crime scene, contains two (2) paint chips which have the following layer structure: 1. Clear colorless topcoat 2. Silver finishcoat with decorative flake 3. White undercoat 4. Dark gray primer 5. Thin medium yellow-gray primer - Apparent metal substrate Microscopical examinations and comparisons between these Item 3 paint chips and the standard paint sample in Item 1 revealed exclusionary differences with respect to layer structure. It is therefore concluded that the Item 3 paint chips from the crime scene could not have originated from the damaged area of the suspect's vehicle as represented by the standard in Item 1.</p>
UF7U3M	<p>The layer structure observed in item 1.3.1 is different from the layer structure observed in item 1.1.1 (known paint exemplar). Therefore, the paint chips from the crime scene (item 1.3.1) could not have originated from the damaged area of the vehicle as represented by the known submitted exemplar (item 1.1.1). The clear layer, the silver colored decorative flake layer, the light grey colored layer, and the dark grey colored layer of item 1.2.1 were compared to the corresponding layers of item 1.1.1. No exclusionary differences in microscopic properties, chemical composition (by Fourier Transform Infrared Spectroscopy) and/or elemental analysis (by Scanning Electron Microscopy-Energy Dispersive Spectroscopy) were observed between analyzed layers from the paint chip from the crime scene (item 1.2.1) and from the analyzed layers from the paint chip exemplar of the damaged area of the vehicle (item 1.1.1). Therefore, the paint chips from the crime scene (item 1.2.1) could have originated from the damaged area of the vehicle, as represented by the known submitted exemplar (item 1.1.1) or from another source with paint exhibiting all of the same analyzed/measured characteristics.</p>
UMPWAP	<p>We received a known sample (Item 1) and two questioned samples (Items 2 and 3). The most relevant results are: All samples contain 4 layers of coating: a transparent clearcoat, an effect basecoat, a ground layer and a primer. The colour of the ground layer in Items 1 and 2 cannot be discriminated; The colour of the ground layer in Item 3 is clearly different when compared to items 1 and 2. The chemical composition of these layers is consistent throughout Items 1-3. The TiO₂ content in item 3 is different when compared to items 1 and 2. We propose two hypotheses (H1 and H2) to interpret these results. H1: Item 1 is the source of the</p>

TABLE 3

WebCode	Conclusions
	<p>trace. H2: An arbitrary other car is the source of the trace. If Item 2 is considered as the trace, we note that the results can be very well explained under H1. The chance that an arbitrary other car (H2) transfers matching paint is very low. The results strongly support H1 over H2. If Item 3 is considered as the trace, we note that the observed colour difference cannot explain under H1. If it is assumed that Item 1 represents the paint on this car completely, we conclude that H1 is excluded and H2 is true.</p>
VGKFEA	<p>Physical examinations indicated that Items 1 and 2 are indistinguishable from one another. However, Item 3 physically differed in layer structure in relation to Item 1. Therefore, Item 3 did not originate from the vehicle represented by Item 1 nor from another vehicle painted in the same manner (Elimination). Chemical analysis of Items 1 and 2 revealed no exclusionary differences in the properties examined. Therefore, Item 2 originated from the vehicle represented by Item 1 or from another vehicle painted in the same manner (Type III Association). This conclusion was reached because other vehicles painted with the same materials applied in the same manner would also be indistinguishable. The following categories and their descriptions are meant to provide context to the conclusions reached in this report. Every category may not be applicable in every case nor for every material. Type I Association: Physical Fit – The items exhibit physical features that demonstrate they were once part of the same object. Associations of Evidence with Class Characteristics: Class characteristics are physical and/or chemical properties that place an item within a particular group of items. Associations of evidence with class characteristics can have varying degrees of significance. In general, the smaller the size of the group relative to the relevant population, the more significant the association. A class association cannot definitively establish that the items came from the same source. Type II: Association with Highly Discriminating Characteristics – An association in which items could not be differentiated. Therefore, the possibility that the items came from the same source cannot be eliminated. Additionally, the items share unusual characteristics that would not be expected to be encountered in the relevant population. Type III: Association with Discriminating Characteristics – An association in which items could not be differentiated. Therefore, the possibility that the items came from the same source cannot be eliminated. Other items have been manufactured that would also be indistinguishable from the submitted items and could be encountered in the relevant population. Type IV: Association with Limitations – An association in which items could not be differentiated. Therefore, the possibility that the items came from the same source cannot be eliminated. As compared to the categories above, this type of association has decreased evidential value. For example, the items are more commonly encountered in the relevant population, a complete analysis was not performed due to limited characteristics or a limited analytical scheme, or minor variations were observed in the data. Inconclusive – No conclusion could be reached. Elimination – The items exhibit exclusionary differences that demonstrate they did not originate from the same source.</p>
VHD9AT	<p>The questioned paint chip recovered from the crime scene (Item 2) could have had a common origin with the known paint sample from the damaged area of the suspect's vehicle. The questioned paint chip recovered from the crime scene (Item 3) could NOT have had a common origin with the known paint sample from the damaged area of the suspect's vehicle.</p>
VPB2HL	<p>The paint from item-2 (questioned paint chips recovered from the crime scene) and item-1 (known paint sample representative of the damaged area of the suspect's vehicle) were consistent on color, layering and chemical composition and could have originated from the same source. The paint from item-3 (questioned paint chips recovered from the crime scene) and item-1 (known paint sample representative of the damaged area of the suspect's vehicle) were inconsistent on color and layering and could not have originated from the same source.</p>
VUFNRW	<p>Item 1 and Item 2 were comparable in layer sequence and layer colours. Item 1 and Item 2</p>

TABLE 3

WebCode	Conclusions
	were comparable chemically as they consisted of the same binder systems; therefore Item 2 could have originated from Item 1.
WP8ZVR	In my opinion, based on the tests available to me, paint samples 1 and 2 are indistinguishable in terms of their microscopic characteristics and chemical composition. Hence, in my opinion there is strong support for the paint samples from items 1 and 2 having originated from a common source. In my opinion, the microscopic characteristics of paint samples 1 and 3 are different. Hence, I am able to exclude paint samples 1 and 3 as having originated from a common source.
XE46CM	After analysis I found: (i) Specimen silver paint "Item 1" is similar to foreign silver paint chips "Item 2" and both appear from the same origin. (ii) Specimen silver paint "Item 1" is dissimilar to foreign silver paint chips "Item 3" and both are not from the same origin.
XKTHDA	Questioned paint chips (Item 2) and known paint sample (Item 1) match in the analyzed physical and chemical properties (number and arrangement of layers in cross-section, hue of layers, chemical composition of binders, fillers and pigments). Considering all the common characteristics, paint sample from Item 2 could originate from the damaged area of the suspect's vehicle. Questioned paint chips (Item 3) and known paint sample (Item 1) differ in the color of the third layer and they do not originate from the same source.
XNTTAA	The results of the examination support that the examined paint chip, in Item 2, originates from the damaged area of the suspects vehicle, from which Item 1 is collected (Level +2). The results of the examination extremely strongly support that the examined paint chip, in Item 3, does not originate from the damaged area of the suspects vehicle, from which Item 1 is collected (Level -4).
YPGPAN	conclusion of paint analysis drawn in the following points: 1. chemical composition and layers pattern of all three items (paint system) are identical. 2. item 3 is different only, because of the 2nd layer thickness (TiO ₂) is approximately double than the 2nd layer thickness (TiO ₂) of item 1 and 2.
ZAJFNN	i) The microscopic examination revealed that Layer 3 of "Item 3" was off-white in colour, whereas Layer 3 of "Item 1" was medium grey. These observations indicate distinguishable characteristics between Layer 3 of "Item 1" and "Item 3." It is therefore concluded that "Item 3" could not have originated from "Item 1." ii) "Item 1" and "Item 2" were physically comparable in terms of the number of layers, colours, and texture. The chemical analysis demonstrated that the paint binders of all layers of "Item 1" and "Item 2" were comparable. It is therefore concluded that "Item 1" and "Item 2" could have originated from the same source.
ZUA7YM	After looking at each under the microscope, the items all had three layers of similar thickness. Item #1 and Item #2 had a top clear or translucent layer, a light gray layer, and a dark gray layer. Item #3 had a white layer instead of a light gray layer, so it does not match Item #1. Infrared spectroscopic analysis was completed on all three layers of Item #1 and Item #2. All of the spectra of the respective layers were similar between Item #1 and Item #2. In summary, based on the similar number of layers, thicknesses, color of the layers, and infrared spectroscopy of the layers, Item #2 may have originated from the same area as Item #1.

Additional Comments

TABLE 4

WebCode	Additional Comments
3WBTRH	The overall case was typical of those cases routinely submitted to this laboratory. However, it was found to be difficult to optically examine in detail the paint chips cross-sectionally, given the substrate.
7BELMA	Considering the number and color of layers, significant visual differences were observed between Item 1 and Item 3 in one of the paint layers. Additionally, the analysis performed by FTIR and Raman spectroscopy determined that both samples have different composition. According to these results, Item 1 and Item 3 have different origins.
7N4KFX	I think a better, more realistic test would involve obtaining paint from actual vehicles. Then the following difficulties/complications could be avoided, which are not typical issues for real-life samples: A) Top layers readily separating from underlying layer(s) in a way that prevents a full cross-section from being obtained. B) For each item, I anticipate that a four-layer system was intended to be a part of the test. However, five layers were present, due to a very thin coating on the surface of the metal substrate, yielding a third primer layer (i.e., 5 total layers). C) That underlying layer was much more difficult to remove from the metal substrate for analysis than is typical for auto paint primers.
8NFKA8	It is unusual that the 1st primer layer of Exhibit 1 (light gray) and Exhibit 3 (white) differ in color yet have the same chemical (FTIR) and elemental (XRF) composition.
8RJFUA	Item 1 and Item 2 cannot be differentiated using the methods applied during the study (visual assessment with a stereomicroscope, Raman spectroscopy, FTIR, and SEM/EDX). Further verification of the common origin of the compared materials would require the use of additional methods (e.g., Py-GC/MS), which, however, are not available in our laboratory.
A7CL3V	Examination using the microscope FTIR could not be conducted as the instrument was temporarily unavailable due to unexpected technical issues.
BARFF8	In casework I would evaluate my findings based on the following two propositions; Hp - The recovered paint chips from the scene (item 2) came from the damaged area of the suspect's vehicle. Hd - The recovered paint chips from the scene (item 2) came from a different source. The findings of recovered paint chips at the scene (item 2) matching the known paint from the damaged area of the suspect's vehicle (item 1) is expected if the recovered paint from the scene (item 2) came from the suspect's vehicle. There is a low expectation of these findings if the recovered paint chips came from a different source. The above findings provide strong support for the view that the recovered paint chips from the scene (item 2) came from the suspect's vehicle, rather than from a different source. I have chosen the above phrase from the following scale: weak support, moderate support, moderately strong support, strong support, very strong support, extremely strong support. My evaluation of the findings is based on my understanding of the circumstances as outlined earlier. If these are different please inform me as re-evaluation of my findings will be necessary.
BLGF8A	In the manufacturer's information if it possible we would like to ask detailed analytical information about the layers. For example: What kind of analytical methods were used for the detection of the differences?
EDVLJ3	The first paint layer was very strongly attached to the metal but not very well to the second paint layer. At the edges of the metal, there was a clear gap between the first and second paint layer, which we never see in real-life cases.
JZAZ26	The difficulty in associating them with certainty lies in the fact that it is only possible to compare four layers of paint of original automotive finishes with common characteristics that are not very individualizing.

TABLE 4

WebCode	Additional Comments
MJTZKW	We conclude that Items 1, 2 and 3 were indistinguishable.
P97LUY	In our laboratory the majority of casework received consists of automobile paint transfer, it is common to receive different exhibits from a real case scenario to compare with a suspect car. Samples of fragments smaller than 0,5 cm and with refinish systems greater than 5 layers are received as typical cases. So far, in my experience, I have not received a case of original finish paint where the chips only differ in the color of an inner layer.
RFW6PP	Due to the many similarities between items 1 and 3, additional comparisons could be considered if known samples from other locations on the vehicle were available.
XNTTAA	Main hypothesis: The examined paint chip originates from the damaged area of the suspects vehicle. Alternative hypothesis: The examined paint chip originates from another vehicle. The explanation and likelihood ratio (LR) for Level 2 are: The results are at least 100 times more probable if the main hypothesis is true compared to if the alternative hypothesis is true. $100 \leq LR < 6\,000$. The explanation and likelihood ratio (LR) for Level -4 are: The results are at least 1 000 000 times more probable if the alternative hypothesis is true compared to if the main hypothesis is true. $LR \leq 1/1\,000\,000$.

-End of Report-
(Appendix may follow)

Test No. 24-5452: Paint Analysis

DATA MUST BE SUBMITTED BY **Nov. 18, 2024, 11:59 p.m. EST** TO BE INCLUDED IN THE REPORT

Participant Code: U1234A

WebCode: VG3FKK

The Accreditation Release section can be accessed by using the "Continue to Final Submission" button above. This information can be entered at any time prior to submitting to CTS.

Scenario:

Police are investigating a hit and run. Police recovered paint chips from the crime scene and, later that day, located a suspect's damaged vehicle that resembled the color of the paint chips recovered at the crime scene. A known paint sample has been collected from the damaged area of the vehicle. Police are requesting that you examine the recovered paint chips and determine if they could have originated from the damaged area of the suspect's vehicle.

Please Note:

-Samples contained within each individual item are representative of a single source.

-The purpose of this test is the examination of the paint; please ignore the metal substrate.

Items Submitted (Sample Pack P2):

Item 1: Known paint sample representative of the damaged area of the suspect's vehicle.

Item 2: Questioned paint chips recovered from the crime scene.

Item 3: Questioned paint chips recovered from the crime scene.

1.) Could either of the questioned paint chips recovered from the crime scene (Item 2 and Item 3) have originated from the damaged area of the suspect's vehicle as represented by Item 1?

	Yes	No	Inconclusive
Item 2:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Item 3:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2.) Indicate the procedure(s) used to examine the submitted items:

Please check all that apply.

Microscopic Exams:	<input type="checkbox"/> Stereomicroscope	<input type="checkbox"/> Polarized Light
	<input type="checkbox"/> Fluorescence	
<input type="checkbox"/> Pyrolysis GC	<input type="checkbox"/> FTIR	<input type="checkbox"/> Solubility/Chemical
<input type="checkbox"/> XRS/XRF	<input type="checkbox"/> SEM/EDX	<input type="checkbox"/> Microspectrophotometry

Other (specify):

Please note: Any additional formatting applied in the free form space below will not transfer to the Summary Report and may cause your information to be illegible. This includes additional spacing and returns that present your responses in lists and tabular formats.

3.) What would be the wording of the Conclusions in your report?

4.) Additional Comments

RELEASE OF DATA TO ACCREDITATION BODIES

The Accreditation Release is accessed by pressing the "Continue to Final Submission" button online and can be completed at any time prior to submission to CTS.

CTS submits external proficiency test data directly to ANAB and/or A2LA. Please select one of the following statements to ensure your data is handled appropriately.

- This participant's data is intended for submission to ANAB and/or A2LA. (Accreditation Release section below must be completed.)
- This participant's data is not intended for submission to ANAB and/or A2LA.

Have the laboratory's designated individual complete the following steps only if your laboratory is accredited in this testing/calibration discipline by one or more of the following Accreditation Bodies.

Step 1: Provide the applicable Accreditation Certificate Number(s) for your laboratory.

ANAB Certificate No.

A2LA Certificate No.

Step 2: Complete the Laboratory Identifying Information in its entirety.

Authorized Contact Person and Title

Laboratory Name

Location (City/State)