



Glass Analysis Test No. 14-548 Summary Report

This test was sent to 124 participants. Each participant received a sample set consisting of one "known" glass fragment (Item 1) and two sets of "questioned" glass particles (Items 2 and 3). Participants were requested to analyze and compare these and report their findings. Data were returned from 99 participants (79.8% response rate) 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 set consisted of three samples of glass, one Known (Item 1) and two Questioned (Items 2 and 3). Items 1, 2, and 3 were from the same Glass Table Topper purchased April 2014 from a local home furnishings store. Examiners were instructed to examine the questioned glass particles and determine if any could have originated from the same glass table as the known recovered glass fragment (Item 1).

SAMPLE PREPARATION-

The glass table topper used for this test was wiped down, checked for defects and edges were avoided.

ITEMS 1, 2, and 3 (IDENTIFICATION): For the known Item 1 samples, one glass fragment approximately 4mm x 4mm in size was selected and packaged into a glassine bag and then a pre-labeled Item 1 coin envelope. For the questioned Item 2 and Item 3 samples, two glass particles approximately 2mm x 2mm in size were selected and packaged in a glassine bag and then an appropriate pre-labeled coin envelope. All items were taken in close spatial proximity to one another, within a 4" x 4" area, and were kept together as an identification group and packaged into the sample set as described below. Care was taken to ensure that fragments from different items were not adjacent to one another so they could not be matched using a physical fracture examination.

SAMPLE SET ASSEMBLY: For each sample set, an Item 1, Item 2, and Item 3 from the same identification group were placed in a pre-labeled envelope. The sample pack was sealed with invisible tape. This process was repeated until all of the sample sets were prepared. Once verification was completed, all sample packs were further sealed with a piece of evidence tape and initialed "CTS."

The average refractive indices for the glass as reported by predistribution laboratories are as follows: Item 1 RI = 1.51905, Item 2 RI = 1.51911, and Item 3 RI = 1.51904.

VERIFICATION-

All three predistribution laboratories reported the expected associations. The methods employed by the predistribution laboratories included Refractive Index nD, UV Fluorescence Long and Short, Color, Thickness, XRS/XRF, SEM/EDS, and physical fit.

Summary Comments

This test was designed to allow participants to assess their proficiency in the examination, comparison, and interpretation of glass samples. Each sample set consisted of three samples of glass, one Known (Item 1) and two Questioned (Items 2 and 3). Items 1, 2, and 3 were from the same Glass Table Topper purchased April 2014 from a local home furnishings store. Participants were instructed to examine the questioned glass particles and determine if any could have originated from the same glass table as the known source. [Refer to the Manufacturer's Information for preparation details.]

Of the 99 participants that reported results, 92 (92.9%) reported that both the Item 2 and the Item 3 glass particles could have originated from the same source as the Item 1 known glass sample.

Of the remaining seven participants, four participants concluded that Item 2 could have originated from the same source as Item 1, but excluded Item 3 as originating from the same source. Two participants reported that Item 3 could have originated from the same source as Item 1 but excluded Item 2 as originating from the same source. The remaining participant reported that Item 2 could have originated from the same source as Item 1 but reported an inconclusive result with regards to whether Item 3 could have originated from the same source as Item 1.

Examination Results

Could the questioned glass particles in Item 2 and/or Item 3 have originated from the glass table as represented by Item 1?

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
293836	Yes	Yes	AHF67N	Yes	Yes
2AXMGN	Yes	Yes	B4ERMV	Yes	Yes
2DARYP	Yes	Yes	BC8732	Yes	Yes
2NFKHH	Yes	Yes	CGGPZU	Yes	Yes
3ME6KB	Yes	Inc	CHPRTK	Yes	Yes
3VMQGR	Yes	Yes	DVP3P7	Yes	Yes
3WGJCB	Yes	Yes	EE49Z8	Yes	Yes
46MPLJ	Yes	Yes	ENJZT4	Yes	Yes
498QQR	Yes	Yes	EPEF8L	Yes	Yes
4MTV6F	Yes	Yes	FGKH4J	Yes	Yes
4YKN9W	Yes	Yes	FYKH9D	Yes	Yes
64B97K	Yes	Yes	G4PXTL	Yes	Yes
68VDKA	Yes	Yes	GCBQJD	Yes	Yes
6DLYX9	Yes	Yes	GZNNWNH	Yes	Yes
6RVH49	Yes	Yes	H4KXCH	Yes	No
7CFN3J	Yes	Yes	H8RACR	Yes	Yes
7W9MNA	Yes	Yes	H9WQHB	No	Yes
8EJ22W	Yes	Yes	HQGBLA	Yes	Yes
8FT274	Yes	Yes	HQKW8G	Yes	Yes
8H6GXJ	Yes	Yes	HWVZPJ	Yes	Yes
984GU4	Yes	Yes	HWBDHL	Yes	Yes
98JTEU	Yes	Yes	JAV4TA	Yes	Yes
ADNHM8	Yes	Yes	JC3BGW	Yes	Yes

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
JQLJFZ	Yes	Yes	UEM68T	Yes	Yes
JWRH37	Yes	Yes	UF8K3M	Yes	Yes
K6XGX7	Yes	Yes	UH74V9	Yes	Yes
KELX72	Yes	Yes	UUWQVP	Yes	Yes
KLHPKW	Yes	Yes	VD9XJQ	Yes	Yes
LMR7A9	Yes	Yes	VFDPDN	Yes	Yes
LWLC92	Yes	Yes	VTPRCT	Yes	Yes
M6PVWP	Yes	Yes	VWPYV7	Yes	Yes
MQAPU3	Yes	Yes	WJXRH2	Yes	Yes
MXNLNB	Yes	Yes	X2RZLQ	Yes	Yes
MYWPAL	Yes	No	X37HPV	Yes	Yes
N4J2HN	Yes	Yes	X6TT6N	Yes	Yes
N8BWLA	Yes	Yes	X8LNPC	Yes	Yes
PB486M	Yes	Yes	XC9R49	Yes	No
PR4GJD	Yes	No	XHF3EM	Yes	Yes
PTKEDX	Yes	Yes	Y7V9HK	Yes	Yes
Q6X766	Yes	Yes	YACKCF	Yes	Yes
QHGM7V	Yes	Yes	YAJKUW	Yes	Yes
QRUHEV	Yes	Yes	YJA6XA	Yes	Yes
RLDVKP	Yes	Yes	YPY9Y7	Yes	Yes
RNEWKL	Yes	Yes	YTXLHP	Yes	Yes
RR9DKN	Yes	Yes	Z3PC6V	Yes	Yes
TRLYJA	Yes	Yes	Z83UKQ	Yes	Yes
TZ7PTA	Yes	Yes	ZA49KC	No	Yes
TZEN98	Yes	Yes	ZACVPX	Yes	Yes

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
ZMM8K7	Yes	Yes			
ZRXC28	Yes	Yes			
ZTPJ8P	Yes	Yes			

Response Summary			Total Participants: 99	
<i>Could the questioned glass particles in Item 2 and/or Item 3 have originated from the glass table as represented by Item 1?</i>				
Response		<u>Item 2</u>	<u>Item 3</u>	
	Yes	97 (98.0%)	94 (94.9%)	
	No	2 (2.0%)	4 (4.0%)	
	Inconclusive	0 (0.0%)	1 (1.0%)	

*See Conclusions (Table 3) and/or Additional Comments (Table 4).

Examination Procedures

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short	Other
293836	✓						✓		✓	✓	✓	
2AXMGN	✓				✓		✓	✓				✓
2DARYP	✓						✓		✓	✓		
2NFKHH	✓						✓		✓	✓	✓	
3ME6KB	✓	✓	✓		✓	✓	✓			✓	✓	Stereo & POL microscopy
3VMQGR	✓			✓	✓		✓					✓ Surface Examination
3WGJCB	✓				✓		✓			✓	✓	LIBS system (ECCO)
46MPLJ	✓			✓			✓	✓				
498QQR	✓				✓		✓			✓	✓	
4MTV6F	✓				✓		✓		✓	✓	✓	
4YKN9W	✓				✓		✓		✓	✓	✓	
64B97K	✓	✓	✓		✓	✓	✓			✓	✓	
68VDKA	✓				✓	✓	✓	✓		✓	✓	LA-ICPMS
6DLYX9	✓						✓	✓				✓ Polarised light examination
6RVH49	✓						✓		✓	✓	✓	
7CFN3J	✓		✓		✓		✓	✓	✓	✓		
7W9MNA	✓				✓		✓		✓	✓	✓	
8EJ22W	✓	✓	✓		✓	✓	✓					✓
8FT274	✓				✓		✓		✓			✓
8H6GXJ	✓			✓	✓		✓		✓			
984GU4	✓				✓		✓			✓	✓	ICP-MS
98JTEU	✓			✓	✓		✓		✓	✓	✓	
ADNHM8	✓						✓	✓		✓	✓	
AHF67N	✓				✓		✓		✓	✓	✓	physical fit
B4ERMV	✓				✓		✓	✓		✓	✓	PLM
BC8732	✓				✓		✓		✓	✓	✓	

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV			
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short	Other	
CGGPZU							✓	✓					
CHPRTK	✓			✓			✓					Surface Analysis	
DVP3P7	✓				✓		✓					LA-ICP-MS	
EE49Z8	✓			✓	✓		✓				✓	Interferometry	
ENJZT4	✓			✓	✓		✓					✓	
EPEF8L	✓			✓	✓		✓			✓	✓	surface features	
FGKH4J	✓	✓	✓		✓		✓			✓	✓		
FYKH9D	✓						✓	✓				✓	
G4PXTL					✓		✓		✓				
GCBQJD	✓				✓		✓					✓	GRIM III, LA-ICP/MS
GZNNWH				✓	✓		✓		✓				
H4KXCH	✓	✓	✓		✓	✓	✓	✓				✓	Dispersion Staining
H8RACR	✓				✓		✓			✓	✓		
H9WQHB	✓				✓	✓	✓	✓		✓	✓		
HQGBLA	✓	✓	✓		✓		✓			✓	✓		PLM, Stereomicroscopy
HQKW8G	✓				✓		✓	✓	✓	✓	✓		
HWWZPJ	✓	✓	✓		✓		✓					✓	
HWBDHL	✓	✓	✓		✓		✓	✓		✓	✓		
JAV4TA	✓				✓		✓	✓					
JC3BGW	✓				✓		✓			✓	✓		ICP-MS
JQLJFZ	✓				✓		✓	✓		✓	✓		
JWRH37	✓	✓	✓				✓		✓	✓	✓		
K6XGX7	✓				✓		✓	✓					
KELX72				✓						✓	✓		
KLHPKW	✓				✓		✓	✓					EMA/WDS
LMR7A9	✓				✓	✓	✓					✓	Tempered vs. Non
LWLC92	✓			✓	✓		✓	✓				✓	
M6PVWP	✓	✓	✓		✓		✓	✓		✓	✓		

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short	Other
MQAPU3	✓				✓	✓	✓		✓	✓	✓	
MXNLNB	✓				✓		✓		✓	✓	✓	
MYWPAL	✓				✓		✓			✓	✓	
N4J2HN	✓				✓	✓	✓		✓	✓	✓	
N8BWLA	✓				✓					✓	✓	
PB486M	✓			✓	✓		✓					✓
PR4GJD	✓	✓	✓		✓	✓	✓	✓				✓
PTKEDX	✓	✓	✓		✓	✓	✓			✓	✓	
Q6X766	✓				✓	✓	✓	✓		✓	✓	
QHGM7V	✓						✓	✓		✓	✓	
QRUHEV	✓				✓	✓	✓			✓	✓	temper, type
RLDVKP	✓			✓	✓		✓					✓ LA-ICP-MS
RNEWKL						✓	✓					LIBS
RR9DKN	✓				✓	✓	✓		✓	✓	✓	
TRLYJA	✓				✓		✓	✓		✓	✓	
TZ7PTA	✓						✓					LA-ICP-MS
TZEN98	✓			✓	✓		✓			✓	✓	
UEM68T	✓			✓	✓		✓	✓				✓
UF8K3M	✓				✓		✓		✓	✓	✓	
UH74V9	✓				✓		✓		✓	✓	✓	PLM
UUWQVP												ICP-MS
VD9XJQ					✓		✓		✓			LASER ABLATION ICP-MS
VFDPDN	✓				✓		✓			✓	✓	
VTPRCT	✓				✓	✓	✓			✓	✓	
VWPYV7	✓				✓		✓		✓		✓	
WJXRH2	✓				✓		✓	✓	✓	✓	✓	
X2RZLQ	✓				✓		✓					
X37HPV	✓				✓	✓	✓	✓		✓	✓	

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV			
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short	Other	
X6TT6N	✓				✓		✓		✓	✓	✓		
X8LNPC	✓				✓		✓	✓				✓	
XC9R49	✓	✓	✓		✓	✓	✓	✓				✓	Dispersion Staining
XHF3EM	✓			✓	✓		✓		✓			✓	
Y7V9HK	✓				✓	✓	✓			✓	✓		
YACKCF	✓				✓		✓					✓	
YAJKUW	✓				✓		✓		✓	✓	✓		
YJA6XA	✓			✓	✓		✓		✓	✓	✓		Examined for physical fit
YPY9Y7	✓				✓			✓				✓	
YTXLHP	✓			✓	✓		✓			✓	✓		LA-ICP-MS
Z3PC6V	✓						✓						
Z83UKQ	✓												
ZA49KC	✓				✓		✓		✓			✓	
ZACVPX	✓				✓			✓		✓	✓		
ZMM8K7	✓			✓	✓		✓		✓	✓	✓		
ZRXC28				✓				✓					
ZTPJ8P	✓				✓	✓	✓	✓		✓	✓		

Response Summary

Participants	Refractive Index				Color	Density	Thickness	Elemental		UV	
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short
99	91	13	14	20	80	20	92	32	32	57	79
Percent	92%	13%	14%	20%	81%	20%	93%	32%	32%	58%	80%

Conclusions

TABLE 3

WebCode	Conclusions
293836	Comparative examinations of Items 2 and 3 (glass) with Item 1 (glass) revealed them to be consistent in their physical characteristics, refractive indices[sic], and elemental composition. Therefore, the glass in Items 2 and 3 could have had a common origin with the glass represented in Item 1.
2AXMGN	The glass fragments recovered from the cuff of the suspect's sleeve (Item 2) and the baseball bat from the suspect's van (Item 3) were consistent in physical properties, refractive index, and elemental composition with the known glass sample from the broken glass table (Item 1). The glass fragments from Item 2 and Item 3 could have originated from the broken glass represented by Item 1 or another source of broken glass with the same properties. The evidence was examined visually and by digital calipers, glass refractive index measurement system (GRIM3), and scanning electron microscopy with energy dispersive spectrometry.
2DARYP	Questioned glass particles from item 2 and item 3 have the same characteristics than known glass from item 1. Questioned glass particles from item 2 and item 3 come from the broken glass table (item 1) or from another glass material with the same characteristics.
2NFKHH	Results: The glass recovered from the cuff of the suspect's sleeve (Item 2) and glass recovered from the baseball bat in the suspect's van (Item 3) are similar in thickness, elemental composition and refractive index in comparison to the glass taken from the broken glass table. The glass from Item 2 and Item 3 could have come from Item 1 or any other broken glass source similar in thickness, elemental composition and refractive index.
3ME6KB	Item 2 could have originated from the same source as the glass in Item 1. It is inconclusive if Item 3 originated from the glass in Item 1.
3VMQGR	Analysis of a sample of the glass recovered from the cuff of the sleeve (Item 2) and from the baseball bat (Item 3) showed that they were indistinguishable from each other and from the control glass sample (Item 1) in terms of thickness, refractive index, thermal history and surface characteristics.
3WGJCB	The questioned glass in Item 2 and Item 3 are consistent with the known glass in Item 1 on the basis of color, thickness, luminescence, refractive index, and elemental composition. Therefore, the questioned glass in Item 2 and Item 3 could have originated from the known glass in Item 1.
46MPLJ	In my view, the findings in this case, provide strong support for the view that the glass in Item 2 has originated from the same source as the broken glass in Item 1, the coffee table. In my view, the findings in this case, provide strong support for the view that the baseball bat has been in forceful contact with the breaking or broken glass from the coffee table, either as the glass was broken or from some subsequent contact with the broken glass.
498QQR	The glass from the suspect's sleeve cuff in Item 2 and the glass from the baseball bat in Item 3 could have originated from the broken glass table represented in Item 1.
4MTV6F	Glass fragments recovered from the cuff of the suspect's sleeve (Item 2) and from the baseball bat (Item 3) are similar in physical properties, optical properties, and elemental composition to the known glass from the broken table (Item 1). It is our opinion that the glass recovered from the cuff of the suspect's sleeve and from the baseball bat could have come from the glass table, or any other glass source with indistinguishable physical, optical, and elemental properties.
4YKN9W	Analysis showed the fragment of known glass taken from the broken glass table (item #1), the broken glass recovered from the cuff of the suspect's sleeve (item #2), and the broken glass

TABLE 3

WebCode	Conclusions
	recovered from the baseball bat in the suspect's van (item #3), were consistent in physical properties, refractive index, and elemental composition. These fragments could have shared a common origin.
64B97K	The glass in Exhibits #2 and #3 could have originated from the same source as the glass in Exhibit #1. Based on the measured refractive index and density, this is a common type of glass.
68VDKA	Item 1 was found to consist of 1 piece of clear and colourless glass fragment. Item 2 and Item 3 were found to consist of 2 pieces of clear and colourless glass fragments. They were examined and found to be consistent with soda-lime-silicate glass. Comparison between Item 2, Item 3 and Item 1: - Item 2 and Item 3 were found to be similar to Item 1 in terms of physical appearance, thickness, density, refractive indices and elemental composition. Hence the questioned glass fragments from Item 2 and Item 3 are likely to have originated from the same source as control glass in Item 1, or another source of glass with similar properties.
6DLYX9	Item 1 (control item) comprised one full thickness fragment of toughened colourless float glass. The fragment was found to have a thickness of 2.88mm, average refractive index of 1.5192 and principally comprised the elements O, Si, Na, Ca, Mg, Al and K. Item 2 comprised two full thickness fragments of toughened colourless float glass. Both fragments were found to have a thickness of 2.88mm, average refractive index of 1.5192 and principally comprised the elements O, Si, Na, Ca, Mg, Al and K. Both fragments corresponded in appearance, refractive index, thickness and gross elemental composition to the control glass (Item 1). These results support the proposition that the glass fragments in Item 2 and the control glass (Item 1) have a common origin. Item 3 comprised two full thickness fragments of toughened colourless float glass. Both fragments were found to have a thickness of 2.88mm, average refractive index of 1.5192 and principally comprised the elements O, Si, Na, Ca, Mg, Al and K. Both fragments corresponded in appearance, refractive index, thickness and gross elemental composition to the control glass (Item 1). These results support the proposition that the glass fragments in Item 3 and the control glass (Item 1) have a common origin.
6RVH49	Based on our examination (RI and XRF) Item 2 and 3 are not distinguishable from Item 1. Therefore both incriminated items could have originated from the broken glass table (Item 1).
7CFN3J	Both the particles of questioned glass recovered from the cuff of the suspect's sleeve (Item 2) and the baseball bat in the suspect's van (Item 3) are identical with the fragment of known glass taken from the broken glass table (Item 1) in color, thickness, UV fluorescence, refractive index, elemental composition and Raman spectrum. Therefore, the questioned glass particles in Item 2 and Item 3 could have originated from the glass table as represented by Item 1.
7W9MNA	The glass from Item 2 (glass from sleeve) and Item 3 (glass from bat) was found to be similar in physical properties, refractive index, and elemental composition in comparison to the glass from Item 1 (standard). The glass from Item 2 and Item 3 could have come from the same source of glass as Item 1 or from another glass source similar in all respects to the glass of Item 1. Chemical Analysis performed includes: Polarized Light Microscopy, Fluorescence, X-ray Fluorescence Spectroscopy (XRF), and Refractive Index. Samples collected and/or analyzed during the examination and analysis of the items in this case (ex. Glass slides) have been returned to and retained with the original item.
8EJ22W	The glass in Item 2 could have originated from the same source as the glass in Item 1. The glass in Item 3 could have originated from the same source as the glass in Item 1.
8FT274	With respect to its refractive index (and by visual inspection) "Item 2" and "Item 3" are not distinguishable from "Item 1". This supports the assumption, that all three samples have the same origin.

TABLE 3

WebCode	Conclusions
8H6GXJ	Comparative examinations of the questioned glass fragments in Item 2 and Item 3 with the known glass fragments in Item 1 disclosed them to be indistinguishable in their physical characteristics, elemental composition and refractive indices. Questioned glass particles from the cuff of the suspect's sleeve (Item 2) and from the baseball bat (Item 3) either originated from the broken glass table (Item 1) or from another source coincidentally indistinguishable in physical characteristics, elemental composition and refractive indices.
984GU4	Microscopic and instrumental analysis and comparison of Item 2, glass from suspect's sleeve, and Item 3, glass from baseball bat, with Item 1, glass from broken table, revealed them to be the same with respect to physical properties, refractive index, and elemental composition. Therefore, the glass from the suspect's sleeve and baseball bat came from the broken table or another source of broken glass with identical physical properties, optical properties and elemental composition.
98JTEU	Examinations of the glass particles in Items 2 (questioned glass recovered from the cuff of the suspect's sleeve) and 3 (questioned glass recovered from the baseball bat in the suspect's van) disclosed them to be consistent with the glass fragment in Item 1 (known glass taken from the broken glass table) in their physical characteristics, elemental composition, refractive index, and thermal characteristics. As a result of these findings, the glass particles in Items 2 and 3 either originated from the glass table as represented by Item 1 or from another source of broken glass indistinguishable in all of the observed or measured physical and thermal characteristics, refractive index, and elemental composition.
ADNHM8	I formed the opinion based on the techniques used, that the glass fragments recovered from the cuff of the suspect's sleeve Item 2, had the same appearance, RI and elemental composition as the control glass taken from the broken glass table Item 1, and could have originated from it. I also formed the opinion based on the techniques used, that the glass recovered from the baseball bat Item 3, had the same appearance, RI and elemental composition as the control glass taken from the broken glass table Item 1 and could have originated from it.
AHF67N	The reference piece of glass previously recovered from the glass table (Item #1) compares by physical, optical & elemental properties to the glass pieces previously recovered from the cuff of the suspect's sleeve (Item #2) & the glass pieces previously recovered from the baseball bat in the suspect's van (Item #3). This indicates that Items #1, #2, & #3 could have a common origin or could have originated from another glass source with indistinguishable properties.
B4ERMV	1. The glass in Item 2 and in Item 3 was consistent macroscopically, microscopically, and instrumentally (refractive index and elemental composition) with the glass in item 1. This indicates that the glass chips in item 1, item 2, and item 3 could share a common origin.
BC8732	It was determined utilizing visual examination and measurement, Glass Refractive Index Measurement System (GRIM3), and X-Ray Fluorescence that the glass samples from item 001, item 002 and item 003 exhibit consistent color, thickness, refractive index and elemental composition. Therefore, based on those characteristics the known sample from item 001 cannot be eliminated as being the source of the questioned glass from item 002 and item 003.
CGGPZU	The evidence (elemental composition) provides support for the proposition that the glass fragment described as Item 2 and Item 3 could be originated from the control sample (item 1).
CHPRTK	Item 2 – Cuff of Sleeve The findings provide moderate support for the proposition that the glass from the cuff originated from the coffee table, rather than it originated from another source. Item 3 – Baseball Bat The findings provide moderate support for the proposition that the baseball bat was used to break the coffee table rather than it was not used to break the coffee table.

TABLE 3

WebCode	Conclusions
DVP3P7	The particles of questioned glass recovered from the cuff of the suspect's sleeve (Item 2) and the particles of questioned glass recovered from the baseball bat in the suspect's van (Item 3) are similar in refractive index and in chemical composition, compared with the known glass (Item 1) taken from the broken glass table. These results are much more likely if the questioned glass particles (Item 2 and Item 3) have originated from the broken glass table as represented by Item 1, than if they have originated from a random other glass object.
EE49Z8	The fragments of glass recovered from the cuff of the suspect's sleeve (Item 2) had the same refractive index, colour and thickness as the sample of glass from the broken glass table (Item 1). Both samples of glass were also from sources of flat toughened glass. Therefore, these fragments of glass could have come from the broken table. In my opinion, the glass evidence very strongly supports the suggestion that the two glass fragments from the cuff of the suspect's sleeve have come from the broken glass table. The two fragments of glass recovered from the baseball bat (Item 3) had the same refractive index, colour and thickness as the sample of glass from the broken glass table (Item 1). Both samples of glass were also from sources of flat toughened glass. Therefore, these fragments of glass could have come from the broken table. In my opinion, the glass evidence very strongly supports the suggestion that the glass fragments from the baseball bat have come from the broken glass table.
ENJZT4	The glass recovered from the cuff of the suspect's sleeve matched the glass that comprised the broken coffee table, by the applied laboratory tests. The glass recovered from the baseball bat also matched the glass that comprised the broken coffee table, by the applied laboratory tests.
EPEF8L	Exhibits 2 and 3 originated either from the source of Exhibit 1 or from another source of broken glass having color, refractive index, strengthening and thickness characteristics indistinguishable from Exhibit 1. In a laboratory survey of broken glass from scenes of crime, none of the 7427 samples (i.e. 0%) had color, refractive index, strengthening and thickness characteristics indistinguishable from Exhibit 1.
FGKH4J	Glass recovered from the debris from cuff of the suspect's sleeve (Item 2) and glass recovered from the debris from the baseball bat (Item 3) are indistinguishable in physical properties and refractive indices at 488nm, 589nm and 656nm wavelength to the glass recovered from the table top (Item 1). Therefore the table top (Item 1) cannot be eliminated as a possible source of the glass recovered from the debris from the cuff of the suspect's sleeve (Item 2) and the glass recovered from the debris from the baseball bat (Item 3).
FYKH9D	In my opinion the findings provide moderately strong support for the proposition that the glass in items 2 and 3 have come from the same source as the glass in item 1.
G4PXTL	The morphology and elemental composition of all three items of glass were considered to be the same. Therefore, Items 2 and 3 were considered to have originated from the same source as Item 1, i.e. the broken glass table.
GCBQJD	The glass recovered from the suspect's sleeve and the baseball bat could have come from the table or from another source of glass having the same physical properties, chemical properties, and elemental composition.
GZNNWH	The physical features of the items #2 and #3 (thickness, color, refractive index and trace element concentrations) are identical to the features of item #1.
H4KXCH	No discriminating differences were observed between Item 2 and Item 1. Based on comparisons to the submitted known, Item 1 cannot be excluded as being a possible source of the glass from Item 2. Therefore, the glass from Item 2 could have originated from Item 1 or from another source with broken glass of the same measured characteristics. Differences were observed between Item 3 and Item 1. Based on comparisons to the submitted known, Item 3

TABLE 3

WebCode	Conclusions
	could not have originated from Item 1.
H8RACR	The glass from questioned[sic] "Item 2" and questioned[sic] "Item 3" were found to be consistent with the known glass "Item 1". Therefore the glass from "Item 2" and from "Item 3" could have come from the same source as "Item 1".
H9WQHB	The sample of glass from Item 1.2 has different physical and optical properties than the sample of glass from Item 1.1. The sample of glass from Item 1.2 did not come from the same source as the sample of glass from Item 1.1. The sample of glass from Item 1.3 has similar physical and optical properties and similar bulk elemental content with the sample of glass from Item 1.1. It is possible that the sample of glass from Item 1.3 could have come from the same source as the sample of glass from Item 1.1.
HQGBLA	Item 1 consists of one clear, colorless, tempered float glass fragment. Items 2 and 3 each consist of two clear, colorless, tempered float glass fragments. Items 1, 2, and 3 each include glass particles which are similar in physical and optical properties. The Items 2 and 3 glass particles either originated from the known glass source represented by Item 1 or from another broken glass source with similar properties. Items 1, 2, and 3 were analyzed using stereomicroscopy, polarized light microscopy, calipers, an ultraviolet lamp, and a refractive index apparatus consisting of a phase contrast microscope with a variable temperature stage and a monochromator.
HQQW8G	CONCLUSIONS: The glass recovered from the cuff of the suspect's sleeve (Item 001B) either originated from the broken glass table (Item 001A) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. The glass recovered from the bat in the suspect's van (Item 001C) either originated from the broken glass table (Item 001A) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics.
HVWZPJ	Two fragments of glass each were recovered from Item 2 and Item 3 for comparison with one fragment of glass representing the known broken glass source (Item 1). These glass fragments (Items 2 and Item 3) are indistinguishable in their observed and measured physical properties and refractive indices at 488 nm, 589 nm and 656 nm wavelengths from glass from the broken glass table as represented by Item 1. Accordingly, the possibility that the glass fragments recovered from the debris from the suspect's sleeve as represented by Item 2 and the glass fragments recovered from the debris from the baseball bat as represented by Item 3 originated from the broken glass table as represented by Item 1 cannot be eliminated.
HWBDHL	Items 1-3 were examined visually for surface properties using ultraviolet light. These items were also measured for thickness, refractive index values with the Emmons Double Variation method and elemental properties using Scanning Electron Microscopy/Energy Dispersive Spectroscopy. Items 1-3 were consistent with respect to the measured properties mentioned above. This indicates that 1, 2 and 3 may share a common source of origin.
JAV4TA	On analysis, I found the refractive index of the fragment of known glass Item 1 to be similar to the refractive index of the particles of questioned glass Item 2 and Item 3. Therefore, I am of the opinion that the questioned glass Item 2 and Item 3 could have come from the known glass Item 1.
JC3BGW	Microscopic examination and instrumental analysis and comparison of optical and physical properties and elemental composition of item 1, known tempered glass, in conjunction with items 2 and 3, questioned tempered glass, revealed them to be indistinguishable. Therefore, items 2 and 3 came from the source represented by item 1 or another source with identical optical and physical properties and elemental composition.

TABLE 3

WebCode	Conclusions
JQLJFZ	In relation to colour, thickness, refractive index and elemental composition the two fragments of glass recovered from the cuff of the suspect's sleeve (item 2) were found to be indistinguishable from the glass from the glass table (item 1). Both glass samples were also found to consist of float glass. Therefore these two glass samples may share a common origin. In relation to colour, thickness, refractive index and elemental composition the two fragments of glass recovered from the baseball bat (item 3) were found to be indistinguishable from the glass from the glass table (item 1). Both glass samples were also found to consist of float glass. Therefore these two glass samples may share a common origin.
JWRH37	Examination of Exhibits 2 and 3 showed that they were consistent in glass type, thickness, elemental composition and optical properties with the known glass, Exhibit 1. Therefore, Exhibits 2 and 3 could have come from the same source as Exhibit 1 or another source with the same physical, optical and elemental properties.
K6XGX7	The known glass sample in Item 1 taken from the broken glass table comprised one piece of colourless glass fragment. Each of the questioned glass samples in Items 2 and 3 recovered from the cuff of the suspect's sleeve and the baseball bat in the suspect's van respectively was found to contain two pieces of colourless glass fragments. The questioned glass particles in Items 2 and 3 were found to agree with the known glass sample in Item 1 in color, thickness, elemental composition and refractive index, suggesting that they could have originated from the same source.
KELX72	The glass in Item 2 is consistent in microscopic and chemical characteristics when compared to the known glass sample in Item 1. Item 2 could have originated from the same source as Item 1 or any source of glass that shares the same characteristics as Item 1. The glass in Item 3 is consistent in microscopic and chemical characteristics when compared to the known glass sample in Item 1. Item 3 could have originated from the same source as Item 1 or any source of glass that shares the same characteristics as Item 1.
KLHPKW	Item 2 is indistinguishable from Item 1 by our testing, and therefore they may have originated from the same source. Item 3 is indistinguishable from Item 1 by our testing, and therefore they may have originated from the same source.
LMR7A9	Glass Examination and Comparison: Items #1, #2 and #3 were visually examined and compared using Polarized Light Microscopy, a digital caliper, a comparative density technique and a GRIM2 Refractive Index Measurement system: Based on the fragments examined, Items #1, #2 and #3 were consistent in their physical and optical properties. Therefore, in the opinion of this examiner, Items #2 and #3 could have originated from Item #1 or from another glass source exhibiting the same analyzed characteristics. Further analysis (elemental analysis) is possible but not available at this laboratory.
LWLC92	The results of the examination give support for the hypothesis that the glass particles in Item 2 originate from the glass table as represented by Item 1 (Level +2). The results of the examination give support for the hypothesis that the glass particles in Item 3 originate from the glass table as represented by Item 1 (Level +2).
M6PVWP	The Item 2 glass (said to be recovered from the cuff of the suspect's sleeve) and the Item 3 glass (said to be recovered from the baseball bat in the suspect's van) corresponded in physical characteristics (color, fluorescence, and thickness), Refractive Index (GRIM - 656nm, 589nm and 488 nm) and elemental composition (SEM/EDS) to the known glass from the Item 1 broken glass table. Therefore, the Item 1 glass table cannot be eliminated as being the source of the unknown glass found on the Items 2 and 3 (Type 4 Association). It should be noted that the [Laboratory] currently does not have the instrumentation that would provide for additional discrimination which would allow for a higher association. However, it should also be noted

TABLE 3

WebCode	Conclusions
	that glass fragments can only originate from broken (or damaged) objects and not intact ones. KEY for instrument acronyms: GRIM – Glass Refractive Index Measurement SEM/EDS – Scanning Electron Microscopy/Energy Dispersive Spectroscopy
MQAPU3	Glass found in Item 2 and Item 3 was identical to the glass in Item 1 in physical, optical, and elemental properties. This means the glass recovered from the cuff of the suspect's sleeve and the glass recovered from the baseball bat in the suspect's van could have come from the broken glass table.
MXNLNB	Analysis showed the glass from item #1 and item #2 was consistent in physical properties, refractive index, and elemental composition. These fragments could have shared a common origin. Analysis showed the glass from item #1 and item #3 was consistent in physical properties, refractive index, and elemental composition. These fragments could have shared a common origin.
MYWPAL	The glass in item 2 was found to be identical to the glass in item 1 in optical properties. This means that the particles of questioned glass recovered from the cuff of the suspect's sleeve may have originated from the fragment of known glass taken from the broken glass table. The glass in item 3 was found to be different to the glass in item 1 in optical properties. This means that the particles of questioned glass recovered from the baseball bat in the suspect's van did not originate from from[sic] the fragment of known glass taken from the broken glass table.
N4J2HN	Visual, microscopic examination, density analysis (sink-float) and instrumental analyses (XRF, GRIM III) of questioned glass Q1A and Q1B submitted as lab item 2 as well as Q2A and Q2B submitted as lab item 3 and their comparison to the known glass KA and KB submitted as lab item 1 revealed that there are no discriminating differences and that they are consistent in color, clarity, appearance, thickness, density, response to UV light, elemental composition (XRF) and refractive index (GRIM III). Therefore, it is the opinion of the undersigned that the questioned glass Q1A, Q1B, Q2A and Q2B submitted as lab items 2 and 3 respectively could have originated from the same source as the known glass KA and KB submitted as lab item 1 or any other source exhibiting the same analyzed class characteristics.
N8BWLA	Analysis for the detection and comparison of glass fragments using Physical Characteristics, Microscopy and a GRIM®3 (Glass Refractive Index Measurement) system: Item #1 (Known) and Items #2 and #3 (Questioned) were indistinguishable in the optical/physical properties examined. Therefore, Items #2 and #3 could have originated from Item #1 as represented by the sample submitted/analyzed, or from another glass source exhibiting the same characteristics observed/analyzed. Further analysis (Elemental) is possible but, not available.
PB486M	Particles of questioned glass recovered from the cuff of the suspect's sleeve (Item 2) and from the baseball bat in the suspect's van (Item 3) and fragment of known glass taken from the broken glass table (Item 1) could have a common origin.
PR4GJD	Item 2 could have originated from the table, as represented by the exemplar Item 1, or from another source with broken glass exhibiting all of the same analyzed/measured characteristics. Based on comparisons to the submitted exemplar (Item 1), Item 3 could not have come from the table.
PTKEDX	The glass fragments in Exhibits #2 and #3 could have originated from the same source as the glass fragment in Exhibit #1.
Q6X766	Based on the particles examined, the glass from Item #2 and Item #3 was consistent with Item #1 glass in the physical properties examined, refractive index, and inorganic composition. It was concluded that these particles could have originated from the same source or another source of broken glass with the same properties.

TABLE 3

WebCode	Conclusions
QHGM7V	<p>1). The particles of questioned glass recovered from the cuff of the suspect's sleeve (Item 2) could not be excluded as having come from the broken glass table (Item 1). Therefore, these glass particles came from either the broken glass table or from another source or sources of broken, clear, float glass indistinguishable from Item 1 in thickness, refractive index and elemental composition. 2). The particles of questioned glass recovered from the baseball bat in the suspect's van (Item 3) could not be excluded as having come from the broken glass table (Item 1). Therefore, these glass particles came from either the broken glass table or from another source or sources of broken, clear, float glass indistinguishable from Item 1 in thickness, refractive index and elemental composition.</p>
QRUHEV	<p>Results: Items 1, 2 and 3 were examined using ultraviolet light, stereomicroscopy, a digital caliper, a density comparison technique and the Glass Refractive Index Measurement system (GRIM3). Based on the fragments examined, the Item 2 and Item 3 glass fragments were consistent with the Item 1 glass in color, thickness, temper, float properties, type, density and refractive index. It was concluded that these fragments could have originated from the broken glass source represented by Item 1 or another source of broken glass with the same properties.</p>
RLDVKP	<p>The glass particles recovered from the cuff of the supsect's[sic] sleeve as well as these from the baseball bat found in the suspect's van can originate from the broken glass table.</p>
RNEWKL	<p>The density measurement with gradient column of item 1 yielded a density of 2.4960 g/cm³. The density of items 2 and 3 was also determined to 2.4960 g/cm³. The element oxides of all three items detected by LIBS-analysis match. Furthermore the contents of the element oxides of all three items are in good congruence and within measurement inaccuracy. Therefore the density measurement and the chemical composition according to LIBS shows that all three items originate from the same glass article.</p>
RR9DKN	<p>The questioned glass in Items 2 and 3 were identical to the glass standard in Item 1 in physical, optical, and elemental properties. This means that the glass recovered from the cuff of the suspect's sleeve and the baseball bat in the suspect's van could have originated from the glass table.</p>
TRLYJA	<p>The glass recovered from the cuff of the suspect's sleeve (Item 2) and from the baseball bat in the suspect's van (Item 3) were indistinguishable by appearance, thickness, refractive index and elemental composition to the glass from the broken glass table (Item 1). In my opinion, the glass recovered from the suspect's sleeve (Item 2) and from the baseball bat in the suspect's van (Item 3) could have originated from the same source as the glass from the broken glass table (Item 1).</p>
TZ7PTA	<p>THE FRAGMENT OF KNOWN GLASS TAKEN FROM THE BROKEN GLASS TABLE "ITEM 1", PARTICLES OF QUESTIONED GLASS RECOVERED FROM THE CUFF OF THE SUSPECT'S SLEEVE "ITEM 2" AND PARTICLES OF QUESTIONED GLASS RECOVERED FROM THE BASEBALL BAT IN THE SUSPECT'S VAN EXHIBIT THE SAME RESULTS IN ALL INVESTIGATED CHEMICAL COMPOSITION AND PHYSICAL PROPERTIES.</p>
TZEN98	<p>In our opinion, the glass from Items 2 and 3 could have had a common origin with the control glass from Item 1.</p>
UEM68T	<p>In my opinion, my findings provide: 1) moderately strong support for the proposition that the glass from the cuff, item 2, originated from the broken table at the scene of the incident. 2) moderately strong support for the proposition that the baseball bat, item 3, was in forceful contact with the glass table at the scene of the incident. The strength of the evidence is assessed on a scale of: no support for either proposition, limited, moderate, moderately strong, strong and very strong. Each point on the scale represents a numerical range, which has a logarithmic basis such that each increment provides ten times greater support than the previous one.</p>

TABLE 3

WebCode	Conclusions
UF8K3M	Colorless glass was recovered from the cuff of the suspect's sleeve (item 2) and from the baseball bat in the suspect's van (item 3) that is similar in optical properties, thickness, refractive index, and elemental composition to the known colorless glass from the broken glass table (item 1). It is our opinion that the glass recovered from the cuff of the suspect's sleeve and the glass recovered from the baseball bat could have come from the broken glass table.
UH74V9	Analysis showed the known glass from item #1 and questioned glass from items #2 and #3 were consistent in physical properties, refractive index and elemental composition. These fragments could have shared a common origin.
UUWQVP	Items 1, 2, and 3 were analyzed by Inductively Coupled Mass Spectrometry (ICP-MS). Based on the results for the selected elements, Items 1, 2, and 3 have a similar elemental profile and therefore could have originated from the same source.
VD9XJQ	Color and thickness of all the items are the same. Chemical compositions are also the same. So items 1, 2, and 3 could have originated from the same source.
VFDPDN	Examination and comparison of Items 2 and 3 with Item 1 revealed the items to be glass that were similar in all measured physical and optical properties. Items 1, 2, and 3 could have come from the same source or from other glass with the same properties.
VTPRCT	Items 1, 2 and 3 were examined using a digital caliper, ultraviolet light, a density comparison technique and the Glass Refractive Index Measurement system (GRIM3). Based on the fragments examined, the Item 2 and 3 glass fragments were consistent with the Item 1 glass in color, thickness, float properties, temper, density and refractive index. It was concluded that these fragments from Items 2 and 3 could have originated from the broken glass source represented by Item 1 or another source of broken glass with the same properties. The evidence is being retained for personal pickup.
VWPYV7	The fragments of glass in Exhibits 2 and 3 and the known glass in Exhibit 1 exhibited similar characteristics using the techniques described above. The fragments in Exhibits 2 and 3 could share a common origin with the known glass in Exhibit 1.
WJXRH2	The questioned glass fragments recovered from the cuff of the suspect's sleeve (CTS Item #2) and the questioned glass fragments recovered from the baseball bat in the suspect's van (CTS Item #3) either originated from the broken glass table (CTS Item #1) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics.
X2RZLQ	The particles of questioned glass recovered from the cuff of the suspect's sleeve (Item 2) and from the baseball bat in the suspect's van (item 3) are the same as the fragment of known glass taken from the broken glass table.
X37HPV	Based on the particles examined, the glass from Items #2 & #3 was consistent with Item #1 glass in the physical properties examined, refractive index, and inorganic composition. It was concluded that these particles could have originated from the same source or another source of broken glass with the same properties.
X6TT6N	Glass fragments possess a unique array of properties, such as thickness, refractive index, color and elemental composition that can be examined and compared in an effort to associate questioned crime scene materials to a known source of origin. The refractive index of a transparent material is a measure of how much the speed of light is reduced inside the material and is the most commonly measured property in the forensic analysis of glass. Glass fragments can be chemically characterized based on the concentrations of certain elements present in the glass. Differences in manufacturer controlled elements or manufacturer uncontrolled trace elements may be used to compare glass fragments to known sources. Comparison of these

TABLE 3

WebCode	Conclusions
	<p>physical, optical, and chemical properties involves the recognition and evaluation of characteristics that associate materials, but cannot provide an identification of a questioned sample to a known source to the exclusion of all others. The glass fragments from the cuff of the sleeve (item 2) cannot be excluded from the tested glass from the tabletop (item 1) based on physical, optical, and elemental analysis. Therefore, the glass fragments from the cuff of the sleeve could have come from the tested broken glass tabletop (item 1) or other broken glass with the same physical, chemical, and elemental properties. The glass fragments from the bat (item 3) cannot be excluded from the tested glass from the tabletop (item 1) based on physical, optical, and elemental analysis. Therefore, the glass fragments from the bat could have come from the tested broken glass tabletop (item 1) or other broken glass with the same physical, chemical, and elemental properties.</p>
X8LNPC	<p>Item 1: One colorless glass standard. Item 2: Two pieces of colorless glass were found. The unknown glass from the suspect's sleeve either originated from the standard (Item #1) from the glass- top coffee table or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. Item 3: Two pieces of colorless glass were found. The unknown glass from the suspect's baseball bat either originated from the standard (Item #1) from the glass-top coffee table or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics.</p>
XC9R49	<p>Item 1 could not be excluded as a possible source of the questioned glass in item 2. Therefore, the glass in item 2 could have originated from item 1 or from another broken glass source exhibiting all of the same analyzed/measured characteristics. At the present time, our laboratory does not have additional elemental analysis techniques that may provide further discrimination of these glass samples. Item 1 is excluded as a possible source of the glass in item 3.</p>
XHF3EM	<p>The two glass particles from the cuff of the suspect's sleeve as well as the two particles from the baseball bat matched the control glass sample from the broken glass table with respect to colour, thickness, refractive index before an[sic] after an annealing procedure and chemical composition. Hence there is a serious clue, that these four particles come from the demolished glass table at the scene of crime. Due to the mass product character of glass tableware a different source cannot be excluded. Anymore the change of the refractive index by the annealing schedule indicates, that all glass items are toughened glass. Among a casework database, which consists of more than 3000 control glass items, there was no item, which matched the glass particles from the suspect in terms of all the properties, which were compared.</p>
Y7V9HK	<p>QUESTIONED GLASS PARTICLES OF ITEM 2 AND ITEM 3 EXHIBIT SIMILAR PHYSICAL CHARACTERISTICS AND CHEMICAL PROPERTIES AS KNOWN GLASS FRAGMENT OF ITEM 1, WHICH IS CONSISTENT WITH A COMMON ORIGIN.</p>
YACKCF	<p>Examination of Item #1 revealed it to be one (1) fragment of known glass. Examination of Items #2 and #3 revealed each to be two (2) fragments of questioned glass. One (1) questioned fragment from Items #2 and #3 was compared to the known fragment from Item #1. These two (2) questioned fragments were found to be indistinguishable from the known fragment with respect to color, thickness and refractive index (GRIM III). Based on the above findings, these fragments could have originated from the same source as this known glass; but not exclusively since other manufactured items in this class might be indistinguishable from the submitted evidence. Further discrimination that may result in a more definitive conclusion might be possible with elemental composition analysis. This analysis is beyond the instrumental capabilities of our laboratory.</p>
YAJKUW	<p>Item 1 consists of one full thickness fragment of colorless tempered float sheet glass. This glass</p>

TABLE 3

WebCode	Conclusions
	<p>was used as a standard represented as being from the broken glass table. Item 2 consists of two full thickness fragments of colorless tempered float sheet glass. Microscopic and instrumental examination of these two fragments revealed that they are like the glass in Item 1 with respect to their thickness, refractive index and chemical characteristics. It is therefore concluded that the glass from the cuff originated either from the broken table represented in Item 1 or from another source of broken colorless tempered float sheet glass having these same characteristics. The latter possibility is considered somewhat unlikely. Item 3 consists of two full thickness fragments of colorless tempered float sheet glass. Microscopic and instrumental examination of these two fragments revealed that they are like the glass in Item 1 with respect to their thickness, refractive index and chemical characteristics. It is therefore concluded that the glass from the bat originated either from the broken table represented in Item 1 or from another source of broken colorless tempered float sheet glass having these same characteristics. The latter possibility is considered somewhat unlikely.</p>
YJA6XA	<p>1. Exhibit 1 (fragment of known glass from table) consisted of one fragment of clear, colorless, tempered glass. Exhibit 2 (particles of questioned glass from suspect's sleeve cuff) consisted of two fragments of clear, colorless, tempered glass. Exhibit 3 (particles of questioned glass from baseball bat in suspect's van) consisted of two fragments of clear, colorless, tempered glass. 2. Comparative examinations of the glass fragments in Exhibit 2 (particles of questioned glass from suspect's sleeve cuff) with the fragment in Exhibit 1 (fragment of known glass from table) disclosed them to be indistinguishable in their physical characteristics, elemental composition, and refractive indices. Therefore, the glass fragments in Exhibit 2 and the glass fragment in Exhibit 1 could have had a common source of origin. 3. Comparative examinations of the glass fragments in Exhibit 3 (particles of questioned glass from baseball bat in suspect's van) with the fragment in Exhibit 1 (fragment of known glass from table) disclosed them to be indistinguishable in their physical characteristics, elemental composition, and refractive indices. Therefore, the glass fragments in Exhibit 3 and the glass fragment in Exhibit 1 could have had a common source of origin.</p>
YPY9Y7	<p>The two glass fragments recovered from the sleeve had an indistinguishable refractive index to the control glass sample from the coffee table, thus these glass results support the proposition that the jacket was close (within 1-2m) to the coffee table, when it broke. The two glass fragments recovered from the baseball bat also had an indistinguishable refractive index to the control glass sample from the coffee table and thus could have come from this source.</p>
YTXLHP	<p>The two pieces of glass (Item 2) collected from the cuff of the suspect's sleeve could not be excluded as having come from the coffee table, as represented by Item 1. As such, these two pieces of glass (Item 2) came from either the coffee table or another source or sources of broken clear, colourless, tempered, float glass, indistinguishable from Item 1 with respect to thickness, refractive index and elemental composition. The two pieces of glass (Item 3) collected from the baseball bat could not be excluded as having come from the coffee table, as represented by Item 1. As such, these two pieces of glass (Item 3) came from either the coffee table or another source or sources of broken clear, colourless, tempered, float glass, indistinguishable from Item 1 with respect to thickness, refractive index and elemental composition.</p>
Z3PC6V	<p>This laboratory can make glass exclusions but not glass inclusions. The analysis performed on the samples didn't allow an exclusion of items 2 and 3. Therefore, as far as it can be told by the thickness and the refractive indexes, items 2 and 3 are consistent to item 1.</p>
Z83UKQ	<p>The glass recovered from the cuff of the suspect's sleeve (Item 2) may have a common origin with the glass taken from the broken glass table (Item 1). The glass recovered from the baseball bat (Item 3) may have a common origin with the glass taken from the broken glass table (Item</p>

TABLE 3

WebCode	Conclusions
ZA49KC	1). The findings provide strong support for the proposition that the glass from the broken table, Item 1, and the glass recovered from the baseball bat in the suspect's van, Item 3, originated from the same source. However, the glass from the cuff of the suspect's sleeve, Item 2, can be excluded as having originated from the broken table, Item 1.
ZACVPX	It was found that items 2 and 3 could have originated from item 1.
ZMM8K7	Comparative examinations of Exhibit 1 (known glass taken from the broken glass table) with Exhibit 2 (particles of questioned glass recovered from the cuff of the suspect's sleeve) and Exhibit 3 (particles of questioned glass recovered from the baseball bat in the suspect's van) disclosed them to be consistent in color, thickness, refractive indices, thermal histories, and elemental compositions. Therefore, Exhibits 2 and 3 could have originated from the table as represented by the glass fragment in Exhibit 1.
ZRXC28	It was concluded that these glass sample/fragments/particles could have originated from the broke glass source represent by Item 1, Item 2, and Item 3 or another source of broken glass with the same properties.
ZTPJ8P	Items 1 through 3 were examined visually, microscopically, by density determination, by scanning electron microscopy with energy dispersive x-ray analysis and by determination of refractive index. Known glass (Item 1), reportedly from the broken glass table, was examined and found to be consistent with the questioned glass (Items 2 and 3), reportedly from the suspect's sleeve and baseball bat, with respect to color, thickness, density, gross elemental composition and refractive index. Based on these observations, it is the opinion of this analyst that the known glass (Item 1) and the questioned glass (Items 2 and 3) are of the same type and could have a common origin. This analyst recognizes that other sources of glass with properties consistent with the above glass exist.

Additional Comments

TABLE 4

WebCode	Additional Comments
2NFKHH	Chemical Analysis performed includes: Polarized Light Microscopy, Fluorescence, X-Ray Fluorescence Spectroscopy, and Refractive Index. Samples collected and/or analyzed during the examination and analysis of the items in this case (ex. glass slides) have been returned to and retained with the original item.
3ME6KB	Item 2 is similar in color, type of glass, fluorescence, thickness, density and refractive index to Item 1. Visual differences were observed between Item 3 and Item 1. Item 3 has grinding marks on some edges which were not observed on edges in Item 1. Visual density differences were observed between Item 3 and Item 1 while numerical density results showed the densities to be just within tolerance limits.
3VMQGR	It is not possible to determine if the glass samples in items 2 and, or 3 originated from the source represented by Item 1; however it must be noted that if the glass in items 2 and, or 3 originated from an alternative source or sources, the alternative source/sources would have to match the control glass Item 1 in terms of thickness, refractive index, thermal history and surface characteristics.
46MPLJ	As there is no background information re the numbers of glass fragments found on the items as a whole and as the pieces of glass submitted are considerably larger than those usually found on the surfaces of Items, I have considered only the source aspect of this case.
498QQR	The glass in Item 2 is indistinguishable to the glass standard in Item 1 with respect to color, thickness and refractive index. The glass in Item 3 is indistinguishable to the glass standard in Item 1 with respect to color and thickness. The glass in Item 3 is similar to the glass standard in Item 1 with respect to refractive index. The Student's t-test is utilized to draw conclusions in the comparison of glass samples with respect to refractive index. The Student's t-test parameters are 'two sample assuming unequal variances' and alpha of 0.05. If the t-test passes, the glass sample is reported to be indistinguishable to the standard with respect to refractive index. If the Student's t-test fails and the mean refractive index of the glass sample is within two standard deviations of the mean of the standard, the sample is reported to be similar to the standard with respect to refractive index.
68VDKA	The elemental compositions and refractive indices of Item 1 to Item 3 were found to be similar. Elemental compositions: The match criterion for LA-ICP-MS analysis was set at 4SD range (min 3% RSD) around control sample. The refractive indices for Item 1 to Item 3 were found to be: Item 1: 1.5192 - 1.5193 Item 2: 1.5191 - 1.5193 Item 3: 1.5191 - 1.5193.
CGGPZU	The answer is based on results of calculation of likelihood ratios.
CHPRTK	Item 2 – Cuff of Sleeve Approximately 20 fragments of glass were found. In accordance with laboratory procedure six of these were analysed. Item 3 – Baseball Bat Two fragments were found and both were analysed.
FGKH4J	In addition to our conclusions, we also have "Methods", "Interpretation," "Limitations," and "Remarks" sections in our report. The "Interpretation" section includes guidance as to the weight of the evidence. In our "Methods" section, we are currently including the following statement: "Although the glass fragments are suitable for comparison using chemical composition data, we not currently conducting ICP-OES analysis due to on-going validation studies. The specimens submitted in this case will be held in the Laboratory for comparisons using chemical composition data pending validation of the ICP-OES. At that time, the specimens will be analyzed, and a supplemental report will be issued including these results. It should be noted that in glass specimens where only refractive index data is acquired, the chance of finding coincidentally indistinguishable glass is significantly higher than in specimens where refractive index and chemical composition are measured. Therefore the possibility exists that additional

TABLE 4

WebCode	Additional Comments
	specimens could be eliminated as originating from the same source of glass after acquisition of chemical composition data."
H4KXCH	At the present time, the Forensic Laboratory does not have additional elemental analysis techniques that may provide further discrimination of these glass samples.
HQQW8G	Also on Report... RESULTS: The questioned glass fragments (Items 001B and 001C) were examined for the purpose of determining whether or not they are like the known glass standard from the broken table (Item 001A). The known glass standard from the broken table (Item 001A) is colorless, tempered, sheet, float glass. Examination and comparison of the questioned glass recovered from the cuff of the suspect's sleeve (Item 001B) with the known glass standard (Item 001A) reveals they are alike with respect to physical, optical, and chemical characteristics. It is therefore concluded that the questioned glass recovered from the cuff of the suspect's sleeve (Item 001B) either originated from the broken table (Item 001A) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. Examination and comparison of the questioned glass recovered from the bat in the suspect's van (Item 001C) with the known glass standard (Item 001A) reveals they are alike with respect to physical, optical, and chemical characteristics. It is therefore concluded that the questioned glass recovered from the bat in the suspect's van (Item 001C) either originated from the broken table (Item 001A) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. METHODS OF ANALYSIS: Examinations were performed visually, by stereo microscopy, polarized light microscopy, ultraviolet fluorescence, micrometry, refractive index determination, scanning electron microscopy/energy dispersive x-ray spectroscopy, and x-ray fluorescence spectroscopy.
HVWZPJ	Methods, Interpretation and Limitations Sections are included in an actual report of examination. Although the specimens are suitable for elemental composition determination by ICP-OES, the Laboratory is not currently conducting elemental analysis due to on-going validation studies. The specimens will be held in the Laboratory pending completion of the validation. At that time, the glass will be analyzed by ICP-OES and a supplemental report will be issued containing these results. It should be noted that in glass fragments where only refractive index data is acquired, the chance of finding coincidentally indistinguishable glass is significantly higher than in items where refractive index and elemental composition are measured. Therefore, the possibility exists that additional fragments could be eliminated as originating from the same source of glass after acquisition of elemental composition data.
MYWPAL	Further discrimination that may result in a more definitive conclusion is possible with elemental composition analysis. This analysis is beyond the instrumental capabilities of our laboratory.
PR4GJD	At the present time, the Forensic Laboratory does not have additional elemental analysis techniques that may provide further discrimination of these glass samples.
PTKEDX	This laboratory does not currently include any type of elemental analysis in its standard procedures for glass comparisons.
QHGM7V	The refractive index was measured with a Glass Refractive Index Measurement 3 (GRIM3, Foster and Freeman) system.
RLDVKP	Fragments of the broken glass table show inhomogeneous RIs (nD).
TZ7PTA	STATISTICAL TREATMENT: ON THE ONE HAND, T-TEST FOR THICKNESS AND REFRACTION INDEX. ON THE OTHER HAND, 4SD (PREVIOUS MINIMUM 3% RSD FILTERED) FOR LA-ICP-MS RESULTS.
TZEN98	The glass in Item 2 was similar, in terms of appearance, thickness, refractive index and thermal history to the control glass in Item 1. The glass in Item 3 was similar, in terms of appearance, thickness, refractive index and thermal history to the control glass in Item 1.

TABLE 4

WebCode	Additional Comments
UEM68T	If this had been a real case, I would have asked for the baseball bat to be submitted to the laboratory with the glass fragments in-situ. For the sake of the exercise, I have assumed that the glass found in the baseball bat can indeed be confirmed as being embedded in the surface of the item.
YPY9Y7	Notwithstanding the validity of these conclusions, glass refractive index values are not unique and therefore other sources for the recovered glass cannot be excluded. The opinions expressed in this report are based on statistical analysis of the refractive index measurement and are expressed within the range of no evidence, inconclusive, slightly supports, supports, strongly supports or very strongly supports.
YTXLHP	Of the 2350 samples of broken glass from crime scenes and survey samples examined at this laboratory for which refractive index, thermal history, thickness, and float data are available, 1 (0.1%) is tempered, float glass, indistinguishable from item 1 in refractive index and thickness. A study performed at this laboratory examining 75 samples of vehicle and architectural float glass by LA-ICP-MS resulted in 2775 pair-wise comparisons. Of these pairs, 3 (0.1%) were indistinguishable in elemental composition, using the 10 elements examined in this case. It should be noted that these 3 pairs were differentiated by refractive index.
Z3PC6V	In order to make an inclusion elemental analysis had to be performed. This capability is not available for this lab at this moment.

Appendix: Data Sheet

Collaborative Testing Services ~ Forensic Testing Program

Test No. 14-548: Glass Analysis

DATA MUST BE RECEIVED BY August 04, 2014 TO BE INCLUDED IN THE REPORT

Participant Code:

WebCode:

Accreditation Release Statement

CTS submits external proficiency test data directly to ASCLD/LAB and ANSI-ASQ NAB/FQS. Please select one of the following statements to ensure your data is handled appropriately.

- This participant's data is intended for submission to ASCLD/LAB and/or ANSI-ASQ NAB/FQS. (Accreditation Release section on the last page must be completed and submitted.)
- This participant's data is NOT intended for submission to ASCLD/LAB or ANSI-ASQ NAB/FQS.

Online Data Entry

Visit www.cts-portal.com to enter your proficiency test results online. If you have any questions please do not hesitate to contact CTS.

Scenario:

Police are investigating a violent assault at a residence. A woman claims her ex-boyfriend had entered her house while she was at work and attacked her with a baseball bat when she returned, breaking her glass-top coffee table. Police apprehended the suspect less than an hour later and recovered glass particles from the cuff of the suspect's sleeve as well as embedded in a baseball bat found in the back of his van. Investigators are requesting that you examine and compare the glass particles recovered from the suspect with the fragment recovered from the broken table of the residence.

Please Note:

-Samples contained within each individual Item are from a single source.

-CTS will not reproduce Interpretation Scales, Scale of Conclusions or Terminology Keys in the final report, please do not submit with the participant's data sheet.

Items Submitted (Sample Pack GL):

Item 1: Fragment of known glass taken from the broken glass table.

Item 2: Particles of questioned glass recovered from the cuff of the suspect's sleeve.

Item 3: Particles of questioned glass recovered from the baseball bat in the suspect's van.

1.) Could the questioned glass particles in Item 2 and/or Item 3 have originated from the glass table as represented by Item 1?

Item 2: Yes No Inconclusive

Item 3: Yes No Inconclusive

Please return all pages of this data sheet.

Page 1 of 3

Participant Code:

WebCode:

2.) Indicate the procedures used to examine the submitted items:

Refractive Index:

nD

nC

nF

Δ RI

UV Fluorescence:

Long

Short

Color

Thickness

Density

Elemental Analysis:

SEM/EDS

XRS/XRF

Other (specify): _____

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

4.) Additional Comments

<p>Return Instructions: Data must be received via online data entry, fax (please include a cover sheet), or mail by <i>August 04, 2014</i> to be included in the report.</p> <p>QUESTIONS?</p> <p>TEL: +1-571-434-1925 (8 am - 4:30 pm EST)</p> <p>EMAIL: forensics@cts-interlab.com</p> <p>www.ctsforensics.com</p>	<p>Participant Code:</p> <p>ONLINE DATA ENTRY: www.cts-portal.com</p> <p>FAX: +1-571-434-1937</p> <p>or Toll-Free: 1-866-FAX-2CTS (329-2287)</p> <p>MAIL: Collaborative Testing Services, Inc.</p> <p>P.O. Box 650820</p> <p>Sterling, VA 20165-0820 USA</p>
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Please return all pages of this data sheet.

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RELEASE OF DATA TO ACCREDITATION BODIES

The following Accreditation Releases will apply only to:

Participant Code:

WebCode:

for Test No. **14-548: Glass Analysis**

This release page must be completed and received by **August 4, 2014** to have this participant's submitted data included in the reports forwarded to the respective Accreditation Bodies.

ASCLD/LAB RELEASE

If your lab has been accredited by ASCLD/LAB and you are submitting this data as part of their external proficiency test requirements, have the laboratory's designated individual complete the following.

The information below must be completed in its entirety for the results to be submitted to ASCLD/LAB.

ASCLD/LAB Legacy Certificate No. _____ ASCLD/LAB International Certificate No. _____

Signature _____ Date _____

Laboratory Name _____

Location (City/State) _____

ANSI-ASQ NAB/FQS RELEASE

If your laboratory maintains its accreditation through ANSI-ASQ NAB/FQS, please complete the following form in its entirety to have your results forwarded.

ANSI-ASQ NAB/FQS Certificate No. _____

Signature and Title: _____ Date _____

Laboratory Name _____

Location (City/State) _____

Accreditation Release

Return Instructions

Please submit the completed Accreditation Release at the same time as your full data sheet. See Data Sheet Return Instructions on the previous page.

*Questions? Contact us 8 am-4:30 pm EST
Telephone: +1-571-434-1925
email: forensics@cts-interlab.com*

Please return all pages of this data sheet.

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