



Glass Analysis

Test No. 22-5481 Summary Report

Each participant received a sample set consisting of one set of known glass fragments (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 74 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 set consisted of three samples of glass, one Known (Item 1) and two Questioned (Items 2 and 3). Item 1 was from a picture frame glass, while Items 2 and 3 were from the same replacement glass. Examiners were instructed to examine the questioned glass particles and determine if any could have originated from the same source as the known recovered glass fragments (Item 1).

SAMPLE PREPARATION:

The glass was examined for defects and then broken. Differing items were cut with glass tools to remove the edges and unwanted areas and then processed and packaged separately from each other to prevent cross-contamination.

ITEMS 1, 2, and 3 (ELIMINATION): For the known Item 1 sample, two glass fragments approximately 1/8" x 1/8" in size were selected and packaged in a glassine bag and then into a pre-labeled Item 1 coin envelope. For the questioned Item 2 and 3 samples, two glass particles approximately 1/16" x 1/16" in size were selected and packaged in each glassine bag and then into a pre-labeled Item 2 and Item 3 coin envelope.

SAMPLE SET ASSEMBLY:

For each sample set, an Item 1, Item 2, and Item 3 were placed in a pre-labeled envelope. The sample pack was sealed with invisible tape. Once verification was completed, all sample packs were then 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 = 1.52218, Item 2 RI = 1.51898, and Item 3 RI = 1.51895.

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

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). Item 1 was from a piece of picture frame glass. Items 2 and 3 were from the same piece of replacement glass. Participants were instructed to examine the questioned samples and determine if either set could have come from the known source. (Refer to the Manufacturer's Information for preparation details.)

All 74 responding participants reported that the Item 2 and Item 3 questioned glass sample could not have originated from the Item 1 known glass sample.

The most commonly reported examination methods were thickness (89%), color (65%), short UV (64%), and refractive index (nD) (49%).

Examination Results

Could the questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and/or pair of gloves on the passenger seat (Item 3) have originated from the damaged area of the retail store front window

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
22MGWP	No	No	9CJUJ2	No	No
2D6XQG	No	No	9NYMKW	No	No
2FN8F9	No	No	B4FM8X	No	No
2KHAGM	No	No	BL33BU	No	No
3PRM27	No	No	BQU996	No	No
3RHN6A	No	No	C4V9FE	No	No
3UKLDG	No	No	CCQBGQ	No	No
3Z9CV6	No	No	CEGAZV	No	No
423E67	No	No	CJAC2A	No	No
4MWJL6	No	No	CPF8JN	No	No
4Z3GP6	No	No	CU7M8V	No	No
8LEDZC	No	No	DEP4TZ	No	No
8UM8RJ	No	No	ENV9EP	No	No
8XLJNJ	No	No	ERVJAP	No	No
94PMF3	No	No	EWTVE3	No	No
98RKNA	No	No	GA9HUD	No	No

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
GH3MNE	No	No	PCLDQ3	No	No
GZXF9C	No	No	PKJ39R	No	No
H7HVEV	No	No	QJ3BTF	No	No
HQ8CHN	No	No	R44HN6	No	No
J3DPB9	No	No	RKCF86	No	No
JJNBWK	No	No	T6U4WM	No	No
JPDNZN	No	No	UJ9U79	No	No
KKDZWQ	No	No	UMQRZQ	No	No
L9EK8E	No	No	UN3QVZ	No	No
MPK89F	No	No	UQ7JQJ	No	No
MRN3RH	No	No	UXQJ8W	No	No
MTKDRR	No	No	VF4LGP	No	No
MZ6BJL	No	No	VQPPNN	No	No
N267CM	No	No	VWAMCB	No	No
N687CK	No	No	W2ZGP3	No	No
NEJ4KX	No	No	WEAXXT	No	No
NU7JM9	No	No	Y4JFTC	No	No
P24QJM	No	No	YCCME3	No	No

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
YEZXRA	No	No			
Z4W28J	No	No			
ZCT2G7	No	No			
ZEGDKH	No	No			
ZEXMAC	No	No			
ZU9D8B	No	No			

Response Summary		Total Participants: 74	
<i>Could the questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and/or pair of gloves on the passenger seat (Item 3) have originated from the damaged area of the retail store front window as represented by Item 1?</i>			
Response		<u>Item 2</u>	<u>Item 3</u>
	Yes	0 (0.0%)	0 (0.0%)
	No	74 (100.0%)	74 (100.0%)
	Inconclusive	0 (0.0%)	0 (0.0%)

Examination Procedures

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short	Other
22MGWP						✓			✓			LIBS
2D6XQG	✓				✓		✓		✓		✓	
2FN8F9	✓				✓		✓		✓	✓	✓	
2KHAGM					✓		✓				✓	
3PRM27					✓		✓		✓	✓	✓	LA-ICP-MS
3RHN6A	✓											
3UKLDG				✓								
3Z9CV6					✓		✓		✓		✓	
423E67	✓						✓		✓		✓	
4MWJL6	✓				✓		✓		✓		✓	LA-ICP-MS
4Z3GP6	✓				✓		✓			✓	✓	
8LEDZC					✓	✓	✓			✓	✓	
8UM8RJ							✓				✓	
8XLJNJ					✓		✓				✓	
94PMF3					✓		✓		✓	✓		
98RKNA				✓	✓		✓					
9CJUJ2					✓		✓				✓	LA-ICP-MS
9NYMKW	✓				✓					✓	✓	
B4FM8X				✓	✓		✓					
BL33BU	✓			✓	✓		✓		✓			LA-ICP-MS
BQU996	✓				✓		✓			✓		
C4V9FE	✓				✓		✓					LA-ICP-MS
CCQBGQ	✓				✓		✓		✓	✓	✓	
CEGAZV	✓						✓					Laser Ablation/ICP-MS
CJAC2A	✓				✓		✓				✓	
CPF8JN	✓				✓		✓			✓	✓	
CU7M8V							✓	✓				
DEP4TZ	✓						✓			✓	✓	

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short	Other
ENV9EP					✓		✓		✓		✓	
ERVJAP							✓		✓		✓	visual/stereoscopic exam
EWTVE3	✓						✓		✓		✓	
GA9HUD	✓				✓		✓			✓	✓	
GH3MNE	✓				✓		✓				✓	
GZXF9C	✓						✓				✓	
H7HVEV	✓				✓		✓	✓		✓	✓	
HQ8CHN	✓						✓				✓	
J3DPB9	✓			✓	✓		✓	✓			✓	
JJNBWK					✓		✓					
JPDNZT				✓			✓					
KKDZWQ				✓								
L9EK8E	✓				✓		✓	✓		✓	✓	Macroscopic and microscopic examinations of morphology
MPK89F					✓		✓			✓	✓	stereomicroscope
MRN3RH					✓		✓			✓	✓	
MTKDRR					✓		✓					LA-ICP/MS
MZ6BJL	✓						✓			✓	✓	
N267CM	✓				✓		✓					surface analysis
N687CK				✓	✓	✓	✓	✓			✓	
NEJ4KX	✓				✓		✓				✓	
NU7JM9							✓		✓	✓	✓	Stereomicroscopy and Polarized Light Microscopy (PLM)
P24QJM	✓						✓					
PCLDQ3	✓				✓		✓					
PKJ39R								✓				FTIR
QJ3BTF	✓				✓		✓		✓		✓	
R44HN6	✓						✓			✓	✓	
RKCF86							✓					

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	ΔRI				SEM/ EDS	XRS/ XRF	Long	Short	Other
T6U4WM							✓	✓				X-ray Photoelectron Spectrometer (XPS)
UJ9U79					✓		✓		✓	✓	✓	
UMQRZQ							✓	✓	✓			
UN3QVZ	✓			✓	✓		✓			✓	✓	
UQ7JQJ												ICP-MS
UXQJ8W	✓				✓		✓				✓	
VF4LGP												Laser Induced Breakdown Spectroscopy (LIBS)
VQPPNN							✓		✓			
VWAMCB	✓				✓		✓				✓	
W2ZGP3					✓		✓		✓	✓	✓	
WEAXXT					✓		✓				✓	
Y4JFTC				✓	✓		✓				✓	
YCCME3	✓				✓	✓	✓				✓	
YEZXRA					✓		✓			✓	✓	LA-ICP-MS
Z4W28J				✓	✓	✓	✓	✓	✓	✓	✓	
ZCT2G7					✓		✓		✓	✓	✓	PLM
ZEGDKH	✓					✓	✓		✓			
ZEXMAC					✓		✓				✓	
ZU9D8B	✓	✓	✓		✓		✓	✓				

Response Summary												
Participants	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	ΔRI				SEM/ EDS	XRS/ XRF	Long	Short	
74	36	1	1	11	48	6	66	10	22	24	47	
Percent	49%	1%	1%	15%	65%	8%	89%	14%	30%	32%	64%	

Conclusions

TABLE 3

WebCode	Conclusions
22MGWP	The chemical composition of all three samples was determined with LIBS and XRF. The comparison of the chemical compositions of the samples showed no agreement between Item 1 and the Items 2 and 3. Additionally, the density of the samples was determined. Item 1 has a different density than Items 2 and 3. Conclusion: Item 1 does not originate from Item 2 and Item 3.
2D6XQG	The questioned glass fragments recovered from the cuff of the suspect's pants (item 2) and the questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (item 3) did not match with the known glass fragments recovered from the retail store front window (item 1) in the thickness of glass and in the refraction index. That means, the questioned glass fragments recovered from the cuff of the suspect's pants (item 2) and the questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (item 3) have another source than the glass fragments recovered from the retail store front window (item 1). The results give no evidence to the alleged offender.
2FN8F9	The glass from questioned "item 2" and "item 3" was found to be inconsistent with the known glass "item 1". Therefore, the glass from the "item 2" and "item 3" could not have come from the same source as the glass from "item 1".
2KHAGM	Glass recovered from the cuff of the pants (Item 2) and the pair of gloves on the passenger's seat (Item 3) is different from Item 1. Accordingly, the retail store front as represented by Item 1 is eliminated as a possible source of the glass recovered from the cuff of the pants (Item 2) or from the pair of gloves on the passenger's seat (Item 3).
3PRM27	Questioned glass fragments recovered from the cuff of the suspect's pants (item 2) and those from a pair of gloves on the suspect's passenger seat (item 3) don't come from the retail store front window (item 1).
3RHN6A	The glass fragments recovered from the cuff of the suspect's pants (item 2) and the pair of gloves on the passenger seat (item 3) did not originate from the damaged area of the retail store front window (item 1). Item 2 and Item 3 were indistinguishable from each other and thus could have originated from the same source.
3UKLDG	The glass fragment "Item 2" and the glass fragment "Item 3" do not match the glass fragment "Item 1" in terms of the refractive index of the glass. The glass fragments recovered from the cuff of the suspect's pants (item 2) and pair of gloves on the passenger seat (item 3) could not have originated from the glass fragment from the damaged area of the retail store front window (item 1).
3Z9CV6	Examinations: Visual examination, stereomicroscopy, thickness measurements, ultraviolet radiation, X-ray fluorescence. Results: The known glass fragments (Item 1) differed from the questioned glass fragments (Items 2 and 3) in thickness and elemental composition. The window represented by Item 1 was excluded as a potential source of the glass fragments within Items 2 and 3. (Elimination).
423E67	Utilizing a micrometer, Polarized Light Microscopy, X-Ray Fluorescence Spectroscopy (XRF), and Glass Refractive Index Measurement System (GRIM3), it was determined that the questioned glass from items 2 and 3 exhibit dissimilar physical, chemical, and optical properties with the known glass, item 1. Therefore, the known glass, item 1, can be eliminated as being the

TABLE 3

WebCode	Conclusions
	possible source of the above-mentioned glass from items 2 and 3.
4MWJL6	Two fragments were found in each packing unit (item 1, 2 and 3). All of them had the appearance of colourless glass. Sample 1 differed from samples 2 and 3 in its layer thickness. Samples of the items 1, 2 and 3 were analyzed by XRF, LUCIA and LA-ICPMS (at least 19 isotopes). After evaluating the results obtained, it was found that item 1 could be clearly distinguished from item 2 and 3. In summary, it is reported that it can be excluded that the samples secured from the pants and gloves originate from the damaged glass from the crime scene. It is noted that item 2 and 3 could have originated from the same unknown source.
4Z3GP6	Exhibit 234 (CTS Item 1) consists of two small fragments of transparent, colorless material that is consistent with float glass, described as known glass samples from a store front window. Exhibit 235 (CTS Item 2) consists of two small fragments of transparent, colorless material that is consistent with float glass, described as questioned glass fragments recovered from a subject's pants. Exhibit 236 (CTS Item 3) consists of two small fragments of transparent, colorless material that is consistent with float glass, described as questioned glass fragments recovered from a pair of gloves. The questioned glass fragments in Exhibits 235 and 236 could not have originated from the known glass source represented by Exhibit 234 due to differences in physical and optical properties.
8LEDZC	The questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and a pair of gloves on the suspect's passenger seat (Item 3) were found to be different in thickness and density to those of the known glass fragments recovered from the retail store front window (Item 1). Therefore, in my professional opinion, the questioned glass fragments in Item 2 and Item 3 could not have originated from the known glass fragments in Item 1.
8UM8RJ	The glass fragments recovered from the suspect's pants and vehicle (items 2 and 3) could not have originated from the broken store window. Item 2 and Item 3 had a different thickness than Item 1.
8XLJNJ	The known glass from the retail store front window (item 1) and the questioned glass from the suspect's pants (item 2) have different physical properties. Therefore, the known glass from the retail store front window and the questioned glass from the suspect's pants could not have originated from the same source. The known glass from the retail store front window (item 1) and the questioned glass from the gloves from the passenger's seat (item 3) have different physical properties. Therefore, the known glass from the retail store front window and the questioned glass from the gloves from the passenger's seat could not have originated from the same source.
94PMF3	It was determined utilizing visual examination and measurement and X-Ray Fluorescence that the questioned glass samples from item 2 and item 3 exhibit dissimilar thickness, and elemental composition, then the known sample item 1. Therefore, based on those characteristics the known sample from item 1 can be eliminated as being the source of the questioned glass from item 2 and item 3.
98RKNA	The glass particles recovered from the cuff of the suspect's pants and from the gloves on the passenger seat could not be distinguished. Both traces are different from the recovered glass fragments from the window at the scene. They came from an other source.
9CJUJ2	The results of the examination are considered under the following two hypotheses: H1: one or more float glass fragments from the examined items originate from the broken window. H2: all

TABLE 3

WebCode	Conclusions
	float glass fragments originate from another glass pane. The elemental composition of both glass traces is different from the elemental composition of the reference glass from the broken window of the store. These glass traces cannot originate from the broken window pane. This leads to the conclusion that hypothesis 1 can be rejected and that hypothesis 2 must be true. Additionally is worth noting that the elemental composition of both glass traces cannot be distinguished from each other.
9NYMKW	The questioned glass in item 2 was instrumentally different (refractive index) from the known glass in item 1. This indicates that items 1 and 2 do not share a common origin. The questioned glass in item 3 was instrumentally different (refractive index) from the known glass in item 1. This indicates that items 1 and 3 do not share a common origin.
B4FM8X	On analysis, I found: The refractive index of the questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and the refractive index of the questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (Item 3) to be dissimilar with the refractive index of the known glass fragments recovered from the retail store front window (Item 1). Therefore, I am of the opinion that: The questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and the questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (Item 3) did not originate from the known glass fragments recovered from the retail store front window (Item 1).
BL33BU	Both Item 2 and Item 3 cannot originate from the same source as Item 1. Item 2 and Item 3 can most likely originate from the same source.
BQU996	Based on differences in physical characteristics and refractive index of the samples, item 2 and item 3 could not have originated from item 1.
C4V9FE	The glass fragments from the cuff of the suspect's pants (Item 2) and the pair of gloves (Item 3) differ in their thicknesses, their refractive indices, and their composition as determined by LA-ICP-MS from the reference glass Item 1 and thus cannot have originated from it.
CCQBGQ	Items 1, 2, and 3 each contained 2 fragments of tempered glass. The questioned glass fragments from Items 2 and 3 exhibited differences in their relative elemental composition to the known glass fragments from item 1. Therefore, the glass fragments from items 2 and 3 did not originate from the same source as item 1, as represented by the examined fragments.
CEGAZV	The fragments recovered from the cuff of the suspect's pants (questioned, ITEM 2) and the fragments recovered from a pair of gloves (questioned, ITEM 3) show different results in all the analyses performed than the fragments recovered from the retail store front window (known fragments, ITEM 1).
CJAC2A	Suspect glass fragments of Item 2 and Item 3 did not originate from the broken window of the burgled premises (as referenced by Item 1).
CPF8JN	CONCLUSIONS: Glass identified as recovered from the cuff of pants (Item 2) and from gloves (Item 3) did not originate from the store window (Item 1). RESULTS: Glass identified as recovered from the cuff of pants (Item 2) and from gloves (Item 3) was examined for the purpose of determining if there is any glass present like the known glass standard from the store window (Item 1). The known glass standard from the store window (Item 1) is colorless, non tempered, float, sheet glass. Examination of Item 2 revealed two full thickness glass fragments. Examination and comparison of these two questioned glass fragments recovered

TABLE 3

WebCode	Conclusions
	<p>from the cuff of pants (Item 2) with the known glass standard from the store window (Item 1) reveals they are dissimilar with respect to their refractive indices. It is therefore concluded that these two questioned glass fragments recovered from the cuff of pants (Item 2) did not originate from the store window (Item 1). Examination of Item 3 revealed two full thickness glass fragments. Examination and comparison of these two questioned glass fragments recovered from the gloves (Item 3) with the known glass standard from the store window (Item 1) reveals they are dissimilar with respect to their refractive indices. It is therefore concluded that these two questioned glass fragments recovered from the gloves (Item 3) did not originate from the store window (Item 1). METHODS OF ANALYSIS: Examinations were performed visually, by stereo microscopy, polarized light microscopy, ultraviolet fluorescence, micrometry, and refractive index determination.</p>
CU7M8V	<p>The evidence (elemental composition of glass samples as well as the thickness measurements) provides support for the proposition that glass fragments recovered from the cuff of the suspect's pants (Item 2) and pair of gloves on the passenger seat (Item 3) have not originated from the suspect's windshield (Item 1).</p>
DEP4TZ	<p>Examination and comparison of Item 1 with Items 2 and 3 were found to be glass dissimilar in physical and optical properties. They could not have come from the same source.</p>
ENV9EP	<p>All the glass fragments in Exhibits 1, 2, and 3 were examined visually, with the aid of a stereomicroscope, and using ultraviolet light. All three exhibits contain colorless, full thickness glass of float manufacture. Additionally, each glass fragment was measured for thickness using digital calipers and Xray Fluorescence Spectroscopy (XRF) to assess elemental composition. Although the three exhibits are consistent in visual color and manufacture characteristics, comparison of thickness measurements and XRF data show small but measurable differences between Exhibits 1 and Exhibits 2 and 3. Therefore, based on the glass standard received, the broken retail store window (Exhibit 1) cannot be the source of the recovered glass fragments from either the suspect's pants (Exhibit 2) or the gloves recovered from the suspect's car (Exhibit 3). Evidence will be returned at the earliest convenience.</p>
ERVJAP	<p>The fragments in Exhibits 1, 2, and 3 were examined visually and with the aid of a stereomicroscope. Comparisons between Exhibit 1, the known window standard, and Exhibit 2 and 3 were made using a digital micrometer for thickness measurements, shortwave ultraviolet light to assess surface characteristics, and X-ray fluorescence spectroscopy to determine elemental profiles. The fragments in all three exhibits were determined to be flat, un-tempered glass manufactured by the float process. However, the thickness of Exhibit 1 was noticeably different than the other two Exhibits. Exhibit 1 can also be differentiated from Exhibits 2 and 3 by their elemental profiles. Therefore, the business window as represented by Exhibit 1 is excluded as the source of either Exhibit 2 or 3.</p>
EWTVE3	<p>The glass fragments in Item 2 and in Item 3 were found to be different in their physical properties to the known glass fragments in Item 1. Given the above, the glass fragments recovered from the cuff of the suspect's pants (Item 2) and a pair of gloves from the suspect's passenger seat (Item 3) can be excluded from having originated from the retail store front window (Item 1). Therefore, it is my opinion that the glass fragments recovered from the cuff of the suspect's pants (Item 2) and a pair of gloves from the suspect's passenger seat car (Item 3) did not originate from the retail store front window (Item 1) but originated from an unrelated source. The above is based on the glass fragments from the retail store front window (Item 1) being representative of the whole store front window.</p>

TABLE 3

WebCode	Conclusions
GA9HUD	I formed the opinion based on the techniques used, that the questioned glass fragments recovered from the cuff of the suspect's pants (item 2), had a different thickness and refractive index to the known glass fragments recovered from the retail store front window (item 1) and did not come from it. I also formed the opinion based on the techniques used, that the questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (item 3) had a different thickness and refractive index to the known glass fragments recovered from the retail store front window (item 1) and did not come from it.
GH3MNE	Glass fragments from Items 2 and 3 were found to be distinguishable to the glass from Item 1 with respect to thickness measurements and Refractive Index. Therefore, in my opinion, there is no support for the proposition that either the suspect's pants or the gloves located in the vehicle, were close to the glass window (within 1-2m) at the scene when it was broken.
GZXF9C	The glass fragments from the 'retail store front window' (Item 1) consisted of two colourless, toughened glass fragments. The glass fragments from the 'cuff of the suspect's pants' (Item 2) and from a 'pair of gloves on the suspect's passenger seat' (Item 3) each consisted of two colourless, toughened glass fragments. The glass fragments in Item 2 and Item 3 are distinguishable from the glass from the glass in Item 1 with respect to their thickness and refractive index. Therefore, in my opinion, the glass from the 'cuff of the suspect's pants' (Item 2) and the glass from the 'pair of gloves on the suspect's passenger seat' (Item 3) could not have originated from the same source as the glass from the 'retail store front window' (Item 1).
H7HVEV	Two particles of questioned glass recovered from the cuff of the suspect's pants (Item 2) and two particles of questioned glass recovered from pair of gloves on the passenger seat (Item 3) are different from two fragments of known glass recovered from the damaged area of the retail store front window (Item 1) in thickness, refractive index. Item 2 and item 3 could not originated from the damaged area of the suspect's windshield.
HQ8CHN	The full thickness glass fragments within item 2 and item 3 are distinguishable from the control source in item 1 in terms of thickness and refractive index. Items 2 and 3 have originated from at least one non-matching source. The results of this examination provide no support for the proposition that the glass fragments recovered from the cuff of the suspect's pants, item 2, and from the pair of gloves on the suspect's passenger seat, item 3, could have originated from retail store front window as represented by item 1.
J3DPB9	The pieces of glass in Item 2 (from the cuff of the suspect's pants) do not originate from the retail store front window, represented by Item 1. The pieces of glass in Item 3 (from a pair of gloves in the suspect's passenger seat) do not originate from the retail store front window, represented by Item 1.
JJNBWK	Item 1: Known glass from the retail store front window This item was used for comparison purposes. Item 2: Questioned glass from the suspect's pants' cuffs. This item is comprised of two pieces of glass which are dissimilar in thickness to the known glass from the retail store front window (Item 1). It is our opinion that these pieces of glass did not come from the retail store front window. Item 3: Questioned glass from pair of gloves on the suspect's passenger seat. This item is comprised of two pieces of glass which are dissimilar in thickness to the known glass from the retail store front window (Item 1). It is our opinion that these pieces of glass did not come from the retail store front window.
JPDNZT	Based on the analysis performed, the fragments of glass recovered from the cuff of the suspect's pants (Item 2) and the fragments of glass recovered from the suspect's gloves (Item 3), could

TABLE 3

WebCode	Conclusions
	not have originated from the fragments of glass recovered from the retail store front window (Item 1) known glass sample.
KKDZWQ	The questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and the questioned glass fragments recovered from a pair of gloves on the passenger seat (Item 3) did not originate from the damaged area of the retail store front window (Item 1).
L9EK8E	Item 1 consists of two colorless glass fragments that exhibit characteristics consistent with non-tempered float sheet (window) glass. These fragments have their full thickness. They were used as standards for comparison to the glass in Items 2 and 3. Items 2 and 3 each consist of two colorless glass fragments that have their full thickness and exhibit characteristics consistent with non-tempered float sheet (window) glass. Macroscopic and microscopic examinations and comparisons revealed slight differences between the questioned fragments in Items 2 and 3 and the glass standard in Item 1, with respect to their fluorescence under ultraviolet lamps and their thicknesses. Further microscopic and instrumental examinations and comparisons revealed exclusionary differences between them, with respect to their refractive index values and major chemical characteristics. It is therefore concluded that the glass fragments recovered from the pants and gloves of the subject could not have come from the broken store front window as represented by the glass standard.
MPK89F	METHODS: Items 1, 2, and 3 were examined visually and using stereomicroscopy, a digital caliper, and ultraviolet light. RESULTS AND INTERPRETATIONS: Based on the fragments examined, the Item 2 and 3 glass fragments could not be associated with the Item 1 glass due to differences in thickness (Exclusion/Elimination). Date(s) of testing: 07/05/2022-07/07/2022.
MRN3RH	The examined colorless pieces of glass from the Known glass fragments recovered from the retail store front window (Item 1-1) were found to be different in thickness from the examined colorless pieces of glass from the Questioned glass fragments recovered from the cuff of the suspect's pants (Item 1-2). Accordingly, the colorless pieces of glass from Item 1-1 could not have originated from the colorless pieces of glass from Item 1-2. The examined colorless pieces of glass from the Known glass fragments recovered from the retail store front window (Item 1-1) were found to be different in thickness from the examined colorless pieces of glass from the Questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (Item 1-3). Accordingly, the colorless pieces of glass from Item 1-1 could not have originated from the colorless pieces of glass from Item 1-3.
MTKDRR	Item 2 and 3 could not have originated from the same source as Item 1 since the thickness and elemental compositions differed from Item 1.
MZ6BJL	Item 2 and Item 3 are not consistent with item 1.
N267CM	The questioned glass fragments recovered from the cuff of the suspect's pants (item 2) and pair of gloves on the passenger seat (item 3) did not originate from the damaged area of the retail store front, they originated from another source.
N687CK	The analysis revealed the measured physical and chemical properties of Item #1 differed from Item #2 and Item #3. The glass from Item #2 and Item #3 could not have originated from Item #1.
NEJ4KX	3. In my opinion, the findings show that the glass fragments in Item 2 and Item 3 are different

TABLE 3

WebCode	Conclusions
	from the "Known" glass in Item 1, such that the "Questioned" fragments could not have originated from that source.
NU7JM9	The glass from Item 2 (glass from pants) and from Item 3 (glass from gloves) were found to be different in thickness and elemental composition in comparison to the glass from Item 1 (standard) and did not come from the same source of glass as Item 1. Items 1, 2, and 3 were examined visually and using stereomicroscopy, UV fluorescence, polarized light microscopy (PLM), a digital caliper, and X-Ray fluorescence spectroscopy (XRF). Samples analyzed in this case have been returned to and retained with the original items.
P24QJM	Item 2 and Item 3 do not originate/are not of the same type as Item 1.
PCLDQ3	Item 1 comprised 2 known glass fragments, both were colourless and with thickness agreeing with each other. The questioned glass fragments in Item 2 and Item 3 were both found to differ in thickness and refractive index from the known glass fragments in Item 1, suggested that glass fragments in Item 2 and Item 3 did not originate from the same source as the known glass fragments in Item 1.
PKJ39R	Neither Items 2 nor 3 could have originated from Item 1. The SEM/EDS Analysis shows a higher proportion of Mg contained in both Items 2 and 3 compared to Item 1 and a higher proportion of Ca in Item 1 compared to the two other items. In addition, FTIR analysis suggests that Items 2 and 3 may have a different coating on the glass compared with Item 1.
QJ3BTF	Based on our analysis, the questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and/or pair of gloves on the passenger seat (Item 3) have not originated from the damaged area of the retail store front window (Item 1). They originate from another unknown source.
R44HN6	The glass in Items 2 and 3 was different from the glass in Item 1 (Elimination). This means the questioned glass recovered from the cuff of the subject's pants and recovered from a pair of gloves on the subject's passenger seat did not come from the retail store front window.
RKCF86	The glass recovered from the cuff of the suspect's pants (item 2) and the glass recovered from the gloves on the suspect's passenger seat (item 3) were found to have a different thickness to the glass from the retail store window (item 1) and therefore could not have originated from that source.
T6U4WM	3) Item 1 contained fragments of glass ~1.9 mm in thickness. SEM-EDS measured 13.80 ± 0.15% mass Na ₂ O, 1.549 ± 0.068% mass MgO, 0.335 ± 0.062% mass Al ₂ O ₃ , 71.81 ± 0.34% mass SiO ₂ , 1.54 ± 0.36% mass SO ₃ , 0.190 ± 0.050% mass K ₂ O, and 10.67 ± 0.12% mass CaO (N=10, K=2). XPS did not detect B or Li. The sample is consistent with thin soda-lime pane glass. Item 2 contained fragments of glass ~2.2 mm in thickness. SEM-EDS measured 14.08 ± 0.13% mass Na ₂ O, 3.97 ± 0.10% mass MgO, 0.470 ± 0.058% mass Al ₂ O ₃ , 72.47 ± 0.20% mass SiO ₂ , 0.470 ± 0.076% mass SO ₃ , 0.139 ± 0.066% mass K ₂ O, and 8.40 ± 0.16% mass CaO (N=10, K=2). XPS did not detect B or Li. The sample is consistent with single-strength window glass. The relative compositions of all seven oxides in Item 2 were inconsistent with the composition of Item 1 (inner quartiles of the composition distributions did not overlap). Item 1 is not a possible source for Item 2. Item 3 contained fragments of glass ~2.2 mm in thickness. SEM-EDS measured 14.01 ± 0.11% mass Na ₂ O, 3.950 ± 0.087% mass MgO, 0.458 ± 0.065% mass Al ₂ O ₃ , 72.60 ± 0.28% mass SiO ₂ , 0.436 ± 0.087% mass SO ₃ , 0.131 ± 0.066% mass K ₂ O, and 8.42 ± 0.16% mass CaO

TABLE 3

WebCode	Conclusions
	(N=10, K=2). XPS did not detect B or Li. The sample is consistent with single-strength window glass. The relative compositions of all seven oxides in Item 3 were inconsistent with the composition of Item 1 (inner quartiles of the composition distributions did not overlap). Item 1 is not a possible source for Item 3.
UJ9U79	A glass fragment (Item 2) is dissimilar in thickness and elemental composition to the glass fragments from the retail store front window (Item 1). It is our opinion that this fragment did not originate from the glass fragments from the retail store front window. No analysis was performed on the other glass fragment (Item 2). A glass fragment (Item 3) is dissimilar in thickness and elemental composition to the glass fragments from the retail store front window (Item 1). It is our opinion that this fragment did not originate from the glass fragments from the retail store front window. No analysis was performed on the other glass fragment (Item 3). Item 1 was used as a comparison standard.
UMQRZQ	Item 2 and Item 3 are distinguishable from Item 1. Item 2 and Item 3 have a different thickness and a different element concentration compared to Item 1. Therefore, Item 2 and Item 3 cannot originate from the same source as Item 1.
UN3QVZ	Glass from the store window (item 1) was eliminated as a possible source of the glass from the suspect's pants (item 2) and from the gloves on the suspect's passenger seat (item 3).
UQ7JQJ	Based on the analysis of triplicate 4 mg portions of ground glass fragments by Inductively Coupled Plasma - Mass Spectrometry, the concentration of 4 elements in Item 2 and 5 elements in Item 3 were distinguishable from the concentration of those elements in Item 1. Based on the results Items 2 and 3 could not have originated from Item 1.
UXQJ8W	the two (02) fragments of questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and the two (02) fragments of questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (Item 3); have not the same physical properties (thickness, and refractive index) of the two (02) fragments of the known glass fragments recovered from the retail store front window (Item 1), therefore the questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and the pair of gloves on the passenger seat (Item 3) have not originated from the damaged area of the retail store front window as represented by Item 1.
VF4LGP	Glass debris from Item 1 was not similar in terms of ratio measurements (Magnesium/Silicon) based on trace elemental composition compared to glass debris from Item 2 and glass debris from Item 3, hence most probably the suspect did not commit such larceny.
VQPPNN	All three items were identified as fragments of clear, colourless window/sheet glass. However, Items 2 and 3 were not considered possible sources for Item 1, due to differences in morphology (i.e., thickness) and elemental composition.
VWAMCB	The glass fragments Item 2 and Item 3 are both float glasses and have a thickness of around 2.16 mm. The glass from Item 1 has a thickness of around 1.88 mm and shows a fluorescence on the surfaces in the UV-light. Item 1 also differs in its refractive indices from Item 2 and Item 3. The glass fragments Item 2 and Item 3 can be differentiated by their refractive indices and their thickness from Item 1.
W2ZGP3	Comparative examinations of Exhibit 1 (known glass standard from the retail store front window) with Exhibit 2 (questioned glass fragments recovered from the cuff of the suspect's

TABLE 3

WebCode	Conclusions
	<p>pants) and Exhibit 3 (questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat) disclosed them to be inconsistent in their physical characteristics and elemental compositions. As a result of these findings, the questioned glass fragments in Exhibits 2 and 3 could not have originated from the retail store front window (Exhibit 1).</p>
WEAXXT	<p>Glass recovered from the cuff of the pants (Item 2) and the gloves from the passenger seat (Item 3) is different in thickness from glass from the retail store front window (Item 1). Consequently, the glass from the cuff of the pants (Item 2) and the gloves from the passenger seat (Item 3) did not originate from the same source as the glass from the retail store front window (Item 1).</p>
Y4JFTC	<p>The particles of questioned glass recovered from the cuff of the suspect's pants (item 2) and the particles recovered from the gloves on the passenger seat could not have a common origin with the known glass fragments from the retail store front window.</p>
YCCME3	<p>Known glass (Item 1), reportedly from the store front window, was examined and found to be inconsistent with the questioned glass (Item 2), reportedly from the suspect's pants cuff with respect to thickness (one piece), density, and refractive index. Known glass (Item 1), reportedly from the store front window, was examined and found to be inconsistent with the questioned glass (Item 3), reportedly from the gloves on the suspect's passenger seat, with respect to thickness and refractive index.</p>
YEZXRA	<p>The examined questioned glass fragments from "Item 2" and "Item 3" were found to be different from the control glass fragments from "Item 1" in terms of trace elemental composition. Hence, the questioned glass fragments from "Item 2" and "Item 3" did not originate from the same source as the control glass fragments from "Item 1".</p>
Z4W28J	<p>The questioned glass fragments recovered from the cuff of the suspect's pants (item 2) could not have been originated from the retail's store front window (item 1). The questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (item 3) could not have been originated from the retail's store front window (item 1).</p>
ZCT2G7	<p>The following methodologies were used in the examination of this case: visual examination, physical examination, microscopy, digital calipers, UV fluorescence and XRF. Item 2 was not consistent in physical properties and elemental composition with the known glass standard in Item 1. Therefore, these items could not have shared a common origin. No further analysis was performed. Item 3 was not consistent in physical properties and elemental composition with the known glass standard in Item 1. Therefore, these items could not have shared a common origin. No further analysis was performed.</p>
ZEGDKH	<p>NEITHER ITEM 2 NOR ITEM 3 HAVE ORIGINATED FROM ITEM 1.</p>
ZEXMAC	<p>The pieces of glass in Items 2 and 3 were significantly different, in terms of thickness, from the pieces of glass in Item 1. As such, these pieces of glass did not originate from the same source as the glass in Item 1.</p>
ZU9D8B	<p>Item 2 and Item 3 could not have originated from the same glass source as of Item 1. Item 2 and Item 3 could have originated from the same glass source.</p>

Additional Comments

TABLE 4

WebCode	Additional Comments
22MGWP	Density Item 1=2,5070 g/cm ³ , Density Item 2=2,4963 g/cm ³ , Density Item 3=2,4962 g/cm ³
2KHAGM	Additional sections stating the methods used, the limitations and the interpretation of the conclusions would accompany the conclusions of this report. Also, the word "suspect's" have been eliminated from the item descriptions as this term may introduce contextual bias.
3Z9CV6	An association scale would be included with the report.
98RKNA	Maybe the window at the scene is double-glazing and the recovered glass from the scene did not represent the hole window.
B4FM8X	The refractive index of the questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) to be similar with the refractive index of the questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat (Item 3).
CCQBGQ	The ASTM guidelines for XRF and RI analysis of glass require 9-10 fragments of the known glass.
CJAC2A	Items 2 and 3 were full thickness fragments that were found to be similar in thickness to each other, but different in thickness from control sample Item 1. In a real case scenario no further work would have been carried out, but as this was a 'Glass Analysis' exercise it was considered appropriate to carry out refractive index measurements, which had a similar outcome to the thickness comparisons.
CU7M8V	The thickness of glass fragments from items 2 and 3 differed from glass fragments from item 1. Quantitative elemental composition of glass fragments evaluated based on likelihood ratio (LR) calculation shows that the hypothesis about the different origins of compared items was more probable than the hypothesis that compared pieces originate from the same source. Based on obtained LR values, support for the hypothesis about the different origins of these fragments is extremely strong.
ERVJAP	Note 1: Per submitter instructions, the fragments contained in each item were treated as originating from a single source. Note 2: Agencies are recommended to submit at least 30 fragments from the broken known glass object to allow for full characterization of its properties. A lack of an adequate comparison standard may lead to false exclusions.
L9EK8E	Examinations on the glass in Items 1, 2 and 3 were performed macroscopically, and by use of stereomicroscopy, ultraviolet fluorescence, a micrometer for thickness measurements, a refractive index measurement system and scanning electron microscopy with energy dispersive spectrometry. The samples were also prepared for comparison via x-ray fluorescence spectrometry; however, it was unavailable for this test.
MZ6BJL	It isn't necessary to do other analysis of the glasses.
UMQRZQ	Item 2 and Item 3 are indistinguishable (Thickness and element concentration)
VQPPNN	The distance between original surfaces (thickness) in Item 1 was measured to be 1.90 mm, whereas Items 2 and 3 both had a thickness of 2.17 mm. Furthermore, the elemental composition showed higher wt% calcium (Ca) and lower wt% magnesium (Mg) in Item 1 than in Items 2 and 3. Items 2 and 3 were similar to each other and likely came from the same source.
YEZXRA	Comparison of trace elemental compositions: The match criterion for LA-ICP-MS analysis was set at 4SD range (minimum 3% RSD) around control sample. The elements compared are: Li7, Na23, Mg24, Al27, K39, Ca42, Ti49, Mn55, Fe57, Rb85, Sr88, Zr90, Ba137, La139, Ce140, Nd146, Hf178, Pb208.

TABLE 4

WebCode	Additional Comments
ZCT2G7	Due to the differences in thickness and elemental composition, the examination was discontinued prior to refractive index analysis. This type of analysis is an available option at this laboratory.
ZU9D8B	Thickness measurement averages (mm) (using micrometer): Item 1: 1.922. Item 2: 2.176. Item 3: 2.174. RI measurement averages (RIU): nD: Item 1: 1.52209. Item 2: 1.51889. Item 3: 1.51885. nC: Item 2: 1.52078. Item 3: 1.52074. nF: Item 2: 1.51390. Item 3: 1.51381. SEM/EDS measurements: Semi-quantitative presence of Mg was compared: Item 1: less than 1 wt%. Item 2 and Item 3: more than 2 wt%.

-End of Report-
(Appendix may follow)

Test No. 22-5481: Glass Analysis

DATA MUST BE SUBMITTED BY **Aug. 15, 2022, 11:59 p.m.** TO BE INCLUDED IN THE REPORT

Participant Code: U1234A

WebCode: A9KQN2

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 burglary at a retail store. The point of entry and exit was determined to be through the front glass window. Police apprehended a potential suspect later that day and noticed glass particles on the cuff of his pants. They obtained a warrant for his vehicle and recovered glass particles from a pair of gloves on the passenger seat. Investigators are requesting that you examine and compare the glass particles recovered from the cuff of the suspect's pants and a pair of gloves from the passenger seat with the fragments recovered from the retail store front window.

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: Known glass fragments recovered from the retail store front window.

Item 2: Questioned glass fragments recovered from the cuff of the suspect's pants.

Item 3: Questioned glass fragments recovered from a pair of gloves on the suspect's passenger seat.

1.) Could the questioned glass fragments recovered from the cuff of the suspect's pants (Item 2) and/or pair of gloves on the passenger seat (Item 3) have originated from the damaged area of the retail store front window 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 used to examine the submitted items:

<input type="checkbox"/> nD <input type="checkbox"/> nF	Refractive Index: <input type="checkbox"/> nC <input type="checkbox"/> Δ RI	UV Fluorescence: <input type="checkbox"/> Long <input type="checkbox"/> Short	<input type="checkbox"/> Color <input type="checkbox"/> Density	<input type="checkbox"/> Thickness
Elemental Analysis: <input type="checkbox"/> SEM/EDS <input type="checkbox"/> XRS/XRF				
Other: <input type="text"/>				

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 ASCLD/LAB, 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 ASCLD/LAB, ANAB, and/or A2LA. (Accreditation Release section below must be completed.)
- This participant's data is **not** intended for submission to ASCLD/LAB, 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.
(Include ASCLD/LAB Certificate here)

A2LA Certificate No.

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

Authorized Contact Person and Title

Laboratory Name

Location (City/State)