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Research Paper

A Non-Destructive Technique for the Analysis of Smartphone Tempered Glass Samples for Forensic Purposes

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Abstract— Smartphones and their parts/fragments are becoming more common in crime scenes, and are frequently collected as evidence. Tempered glasses are used as screen protectors for mobile phones and other Portable Electronic Devices (PEDs). These tempered glasses can easily break and can be found at the crime scene. Such glass fragments can be recovered in a range of incidents, including hit-and-runs, burglaries, and ram-raids. Tempered glass, unlike other glasses, is still used even if the screen is damaged or cracked, and continues to be used even in that condition. Glass shards obtained at the site of the crime can be compared to bits found on the suspect/victim to ascertain their origin, which can be useful evidence. In this research, the physical and optical properties, along with the elemental composition, of the tempered glasses were analyzed and compared with a standard Soda lime glass. The dimensions, weight, and density of the glass samples were studied. The samples were observed under Stereomicroscope and also examined under Ultraviolet light using a Video Spectral Comparator (VSC). The elemental composition of the samples was examined further using Energy Dispersive X-ray Fluorescence Spectroscopy (ED-XRF). 3D images from the stereomicroscope showed distinct layers in the tempered glass which were absent in Soda lime glass. The densities of the tempered glass samples were similar in the range of 1.5-2 g/cm3 and slightly lower than those of the Soda lime glass. The edges and the superficial surface of the tempered glasses showed fluorescence in different colors and bands in different brands. The tempered glass samples can be distinguished from common Sodalime glass and even differentiated among different brands. Elemental analysis along with other physical examinations can aid in better discrimination of tempered glass samples.

Keywords— Forensic glass analysis, Smartphone tempered glass, ED-XRF, trace evidence, PEDs.

1. Introduction

According to Locard's concept of exchange, the transfer of glass pieces at a crime scene happens whenever two individuals or items come in contact. Similarly, glass fragments have been discovered in a number of situations, including hit-and-run, burglary, and ram-raid incidents. However, in the vast majority of cases of glass shattering, tiny, irregularly shaped shards of glass with diameters between 0.1 and 2 mm are transferred to clothing. Glass shards obtained at the site of the crime can be compared to fragments found on the perpetrator or victim to determine where they came from, which can be important evidence. The strength of the forensic scientist's judgment is influenced by the type of background data and comparisons utilized, the type of glass involved, whether it is uncommon or frequent, and how well it is characterized. Three crucial steps, namely categorization, discrimination, and individualization, are part of a forensic glass examination. The process of naming and classifying specimens according to measured attributes is known as classification, also referred to as identification. The ability to distinguish between two glass objects of the same class based on their quantifiable characteristics is known as discrimination. The discovery that a sample differs from others in the same class is referred to as individualization [1].

An additional layer of material called a screen protector can be put to the screen of an electronic device to shield it from impact damage. It can be constructed from thermoplastic polyurethane (TPU), tempered glass, PET film, or many layers. Tempered glass is the name for a multi-layered screen protector. It is made of an oil-repellent oleophobic coating, PET film, optically transparent adhesive tempered glass, a bottom layer of absorbent silicon, and tempered glass. Today, there are a variety of glasses available in the market, one of which is tempered glass which is being widely used as a screen protector for portable electronic devices (PEDs) such as smartphones, laptops, smartwatches etc. Since the usage of

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smartphones has increased rapidly, the occurrence of phones and its parts/fragments is common in crime scenarios which should be collected as evidence. Tempered glasses can be easily distinguished from other kinds of glasses in the glass community and it may be narrowed down to a particular brand. Tempered glass, unlike other glasses, is still used even if the screen is damaged or cracked, and continue to use it even in that condition. As a result, it can be a completely new, significant source of glass fragments discovered on people's clothing and property, including individuals who are accused of glass-breaking offenses [2].

In general, glass examination proceeds with the physical examination which involves colour, thickness, and density followed by optical properties like refractive index and fluorescence. Elemental analysis of glass is done by instrumental techniques such as SEM-EDS, EDXRF/Micro-XRF, LA-ICP-MS, and ICP-OES. The EDXRF method for atomic spectrometry relies on the detection of X-ray radiation generated by excited atoms [3]. The X-ray photons of all the elements in a sample are collected simultaneously onto the detector and the energies of the photons are obtained by the electric pulse generated for each photon. The energy of X-rays emitted is characteristic of the welement and hence the inorganic elements present in the glass can be detected. The intensity of the element can be used for quantitative analysis [3].

Common tempered glasses can be distinguished from other types of glasses using refractive index and elemental analysis using ICP-MS, SEM-EDX and XRF spectroscopy. In this research, we aim to analyze and compare different brands of smartphone tempered glass and study their applications in forensics by physical and optical examinations followed by elemental analysis using ED-XRF (Energy Dispersive X-Ray Fluorescence spectrometry).

Upcoming sections include Section 2 which discusses previous studies on the said topic, Section 3 includes the methodology used for conducting this study, and finally, section 4 which contains the results and discussion.

2. Related Work

A thorough investigation on glass shards found in portable electronic devices (PEDs) was done by Seyfang et al. To see if PED screens could be distinguished from other glass populations, they used a variety of techniques, including glass refractive index measurement (GRIM), XRF, SEM-EDS, and LA-ICPMS. It was discovered that PED glass samples had a lower RI than glass from vehicle windows, etc. When ANOVA and Tukey's test were combined, it was evident that most of the samples could be distinguished from one another. Furthermore, LA-ICP MS made it simple to quantify certain elements including Fe, Cr, Ti, Ca, Ni, and Cu that SEM-EDS was unable to identify. In terms of Ca abundance and K distribution, distinct characteristics between PED glass and soda-lime glass were also discovered. The overall discrimination power when XRF analysis was added to RI was greater than 99% [2].

In yet another study, screens of 30 different PEDs, screen protectors, and liquid glass were examined using µ-XRF. The spectral overlay method was used for the analysis and discrimination between the PED screens and Screen protectors was achieved and could be grouped into 5 groups of PEDs and 4 screen protector groups. Discrimination of samples within each group was also accomplished due to differences observed in signal intensities [4].

Civici, N., & Vataj, E. presented a method for non-destructive examination of automotive glass samples of different brands using ED-XRF spectrometry. Samples were typically obtained from the front windshield of the car in which the glass is sandwiched with a layer of plastic in between. ED-XRF analysis revealed that the main constituents were SiO2, Na2O and CaO commonly known as soda lime-silicate glasses. They also carried out a comparative analysis of the top and bottom layers of the glass, and there was no significant difference in the composition reported. Additionally, tin (Sn) was found on both the surfaces of the glass which indicated that the car glasses were manufactured with the float-glass method where a layer of molten glass flows over tin and is cooled [5].

XRF has been used in real time cases in recent times for analysis of evidence such as glass artefacts, crime scene analysis of glass evidence and even for testing the purity of gold and silver (in ornaments). One such case study is presented by Jha, S., & Sharma, M in which the authors established a link between the questioned and control samples from a road accident. Out of the many samples that the forensic lab received, a preliminary examination of RI was conducted using GRIM from which the best match was further subjected to XRF analysis. Questioned samples (Q1 & Q2) were compared along with the control sample (C1) using a Wave-length dispersive XRF spectrometer (WD-XRF). Qualitative analysis showed that the elements detected were the same in both exhibits. Q1 & C1 showed almost the same intensities and the percentages of compounds were in agreement with each other. Hence, they proved that XRF is a versatile and non-destructive method for analyzing trace evidence and should be utilised to its full purpose [6].

Another type of XRF, called the micro-XRF, was studied by Gelb, J., & Yang, X. They did a comparative study and quantification of layers on three tempered glasses made from different manufacturers using µXRF. The glasses were reported to have the same hardness values of 9H but they differed in their composition. Specimens were labelled as 1-DT, 2-GG, and 3-HG and their optical micrographs were first obtained. Quantitative analysis showed that samples 1-DT & 2-GG showed similarity in weight % of Si, K, and Ca, with trace amounts of Ti, whereas the 3-HG specimen exhibited a completely different composition showing other trace elements like Pt, Sn, and Al. This was followed by local elemental mapping which revealed the composition at various points throughout the cross-section of each specimen [7].

In the study by Hicks et. al., small glass pieces were studied using Refractive Index measurement by GRIM and elemental

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analysis using ED-μXRF. A total of 200 samples were collected from glass fragments of windows, containers, headlamps, etc., obtained from crime scenes or broken at random by acquaintances. Classification of glass samples was implemented by Linear Discriminant Analysis (LDA) and Neural Networks (NN). was used Discrimination of the samples was done by Hotelling's T2 test. Classification of the glass fragments was not possible using Refractive Index measurements. NN and LDA using qualitative and semi-quantitative ED-μXRF data allowed classification with high reliability. In general, NN outperformed LDA, however while employing NN, a higher percentage of window readings were categorised as vehicles. The discriminating power using Refractive Index was high and the glass fragments that couldn't be differentiated using RI was analysed by ED-μXRF which distinguished 112 out of 129 pairs of window panes. ED-μXRF proved to be less discriminating than ICP-MS but more discriminating than SEM-EDX. But the technique is non-destructive and requires less sampling preparation unlike the others [8].

The research by Robert et al., focused mainly on discrimination of glass fragments from similar type of glasses using RI, ED-XRF and ICP-AES. Glass fragments of smaller size in the <5mg range from 81 tempered sheet automobile window glasses were used as samples. Refractive index measurements provided good discrimination of glass samples of different sources. Glass fragments were analysed using ED-XRF by suspending it on adhesive tape. Large samples were crushed into small fragments due to poor precision resulting from longer acquisition time. However, quantitative elemental concentrations were not able to be obtained with sufficient accuracy due to the small size and irregular shaped fragments. Discrimination was provided by Fe:Ca and Sr:Zr ratios as parameters. However, two similar samples were indistinguishable. ED-XRF along with Refractive Index provided better discrimination than Refractive Indices alone. Concentration of Zirconium (Zr) was greatly helpful in discrimination in cases of highly indistinguishable samples. ICP-AES offered quantitative concentrations of elements with precision, higher number of elements along with greater number of parameters for discrimination [9].

Another study by Howden et al., aimed at proposing a method to analyze small glass fragments of size less than 100 μg using ED-XRF. Glass fragments with similar refractive indices were largely considered. The sampling was carried out in two ways using a specially designed sample holder and the other way by using glass dispersions on millipore filter pad. Alternative sampling methods are described such as nylon fibres, mini collimators. The sample holder is preferred owing to its simplicity and low risk of losing fragments compared to other methods. Discrimination of glasses with similar refractive indices can be obtained with better results [10].

Another study assessed the effectiveness of μ-XRF and LIBS analyses in characterizing glass homogeneity compared to LA-ICP-MS quantitative analysis. According to the research, the RSD for the elemental composition of 100 fragments from two separate windshield panes was less than 10% for both -XRF and LIBS, and less than 5% for LA-ICP-MS. Comparison methods with more fragments of the known sample showed better performance as the number of fragments increased. The results suggest that comparison criteria should be chosen based on the instrument's precision and sensitivity, with error rates below 3% for μ-XRF and LIBS [11].

In a mock study, the transfer and persistence of glass shards during vehicle window breaking, their persistence through various activities, and their proneness to secondary transfer was evaluated. Background glass was collected before the incident, and a kidnapping scenario was devised. Evidence was collected from the victim, suspects, car exterior, and interior of both vehicles. Results showed low persistence of glass in individuals not involved, while primary and secondary transfer fragments varied in size and distribution. Fragment distribution patterns and probable passenger transfer after similar breaking occurrences were revealed by glass recovery inside the car. Secondary transfer of glass was observed during suspect-victim interaction, driving activities, and crime scene recovery [12].

The effectiveness of contemporary XRF systems with silicon drift detectors (SDDs) for forensic glass examination was assessed in recent interlaboratory research. High erroneous exclusion rates for same-source samples were seen despite the SDD-XRF devices' improved precision and detection limitations. The number of fragments obtained for the known source was increased, and the suggested comparison criteria were changed, as two strategies to lower erroneous exclusion rates were explored. The findings show improved sensitivity and precision in glass measurements acquired with μXRF-SDD systems [13].
Similarly, studies for other kinds of glass have also been done in the last few years [14] [15] which can also be found in forensic scenarios.

3. Experimental Procedure:

3.1. Sampling

Convenience sampling was used to choose brands of tempered glasses from higher to lower-cost selected from the E-Commerce platform (Amazon).

Number of brands used = 15
Number of Tempered glass samples from each brand = 01
Total number of samples = 15

3.2. Sample Preparation

The tempered glass samples were stored and handled in EPE Foam Pouches. The Tempered glass samples were polished gently with acetone and used for analysis in their intact form.

3.3. Analysis:

Physical Examination: Physical dimensions of the tempered glass samples such as Length and Breadth were measured using a Measuring Scale in Centimeters. Thickness was

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measured using Digital Vernier Calipers. Finally, the weight of the tempered glass sample was measured using a weighing balance. Then Density was calculated using the formula:

Density= Mass / Volume (Length x Breadth x Thickness)

Microscopic and UV Examination: The colour and layers of the tempered glass samples were analyzed using a Stereo Microscope (Smart Cam Integrated HD Digital camera, Vision Engineering).

Later the glass samples were observed under various light sources using Video Spectral Comparator (VSC 6000/HS Foster Freeman) for observing the fluorescence if any.

Elemental analysis: Microscopic examination was followed by elemental profile of all the tempered glass samples using ED-XRF spectrometer (EDX 7000, Shimadzu, Japan) with a Silicon Drift Detector (SDD). PCEDX software was used for the analysis and interpretation.

Working conditions
Atmosphere: Air
Source: Rhodium (Rh)
Collimator: 3mm
Voltage: 4 kV to 50 kV
Current: 1 µA to 1000 µA
Measuring range: $_{11}$Na to $_{92}$U

4. Results and Discussion:

Significant differences were observed in terms of physical and microscopic examination followed by ED-XRF analysis which indicates that this methodology can be adopted for the analysis of different brands and also with other kinds of glass.

It can also be used to classify and discriminate tempered glass from soda-lime glass. ED-XRF is a powerful, non-destructive tool for analyzing tempered glass samples without much sample preparation or surface treatment. Whenever such evidence is encountered at a crime scene, this study may prove helpful in the examination of such types of glass.

4.1. Physical Examination:

The physical dimensions of the samples were measured along with thickness and density. The thickness of the soda lime glass was 1.37mm while the average thickness of all tempered glass samples was found to be 0.57mm. The thickness of the examined samples of tempered glass ranged from 0.39mm to 0.74mm, according to the analysis. Most tempered glass samples were found to have a thickness in the range of 0.6mm to 0.7mm.

The density of tempered glass was calculated which was found to be in the range of 1.3-2.2 g/cm3. The density of the standard soda-lime silicate glass was 2.39 g/cm3. The tempered glass is distinctly lesser in density than that of the examined soda lime glass.

4.2. Microscopic and UV examination:

Preliminary examinations of the layers of tempered glass were studied using a Stereomicroscope. 3-Dimensional images of the glass edges have shown distinct glass and plastic layer along with manufacturing differences. There was an absence of layers in the soda-lime silicate glass as compared to those that were observed in tempered glass. Samples with lesser thickness <0.50mm appear to have more compressed layers allowing lesser light to pass through.

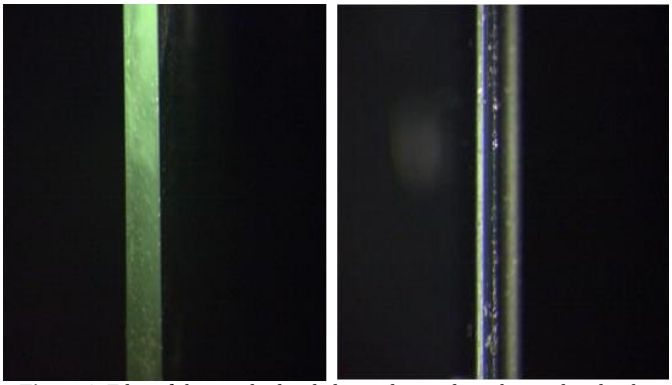

Figure 1. Edge of the standard soda lime silicate glass observed under the Stereomicroscope (left) and the Edge of a tempered glass sample as viewed under the Stereomicroscope (right). Distinct layers can be seen in tempered glass sample whereas layers are absent in soda lime glass.

Glass surfaces and edges were examined under UV light at 254nm & 365nm in Video Spectral Comparator (VSC). Characteristic differences were observed in the fluorescence with respect to color. At 254 nm, the edges of certain samples gave bluish-violet fluorescence whereas others gave yellowish fluorescence. Some samples also fluoresced with two colours simultaneously as two distinct bands i.e. blue & brown or blue & green. At 365nm, all the samples' edges produced a bright whitish-blue fluorescence with minute differences. The surface of the glass samples produced less fluorescence than the edges. Few samples showed bright color fluorescence compared to others. But both the edges and surface of the standard sample did not produce any appreciable fluorescence in either wavelength which can be a unique property attributed to only tempered glass.

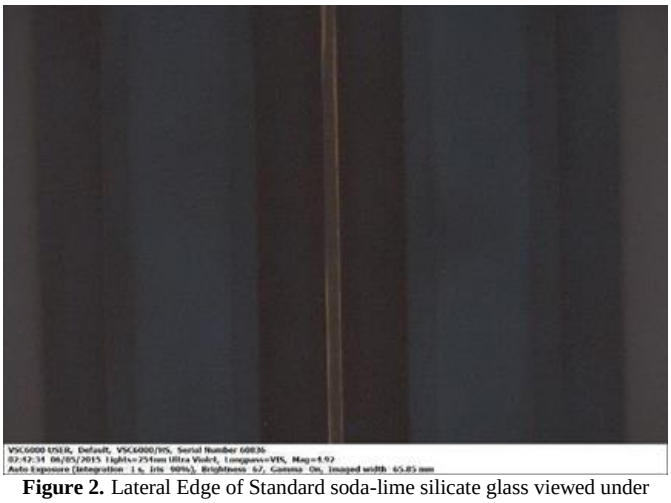

Figure 2. Lateral Edge of Standard soda-lime silicate glass viewed under 254nm UV

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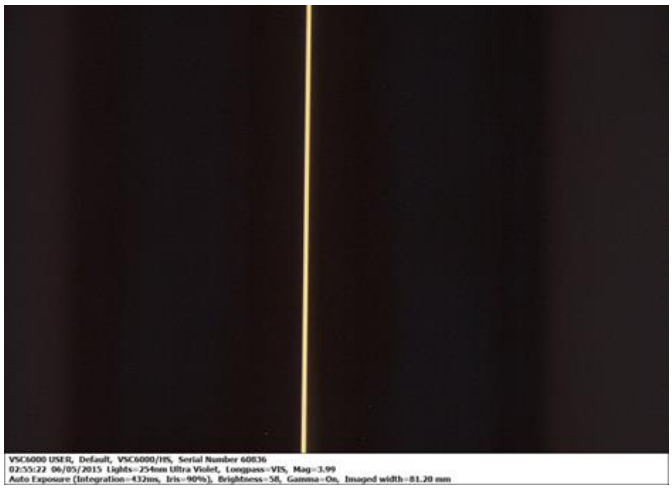

Figure 3. Lateral edge of Tempered glass sample under 254nm UV

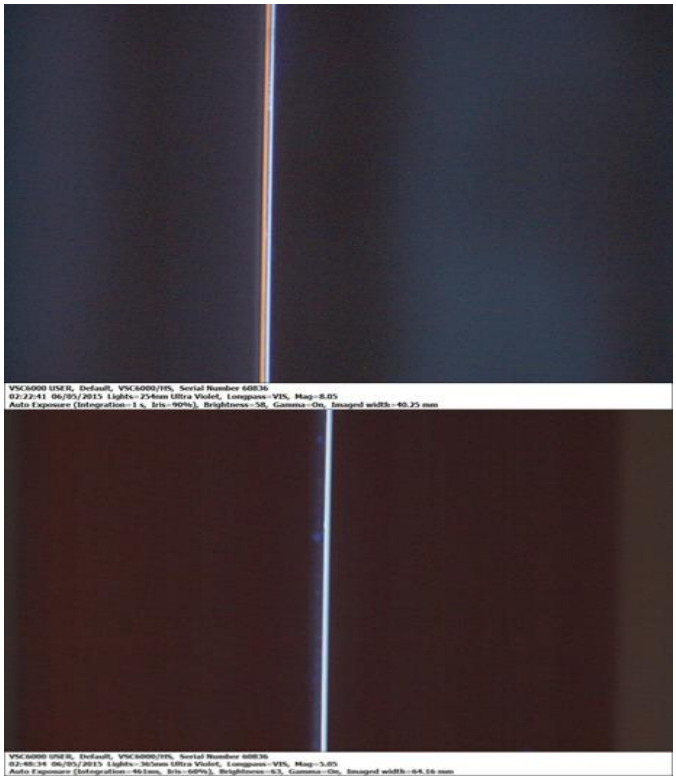

Figure 4. Lateral Edges of different tempered glass samples viewed under Ultraviolet light. Orange and blue bands are visible at 254nm UV (top) White and blue bands are visible at 365nm UV (bottom)

4.3. Elemental analysis using ED-XRF:

All the samples were further analysed for their elemental composition using ED-XRF. Silicon was observed to be the most abundant element present in all the samples (~90%) including the standard soda-lime silicate glass sample (60%). The concentration of silicon is observed to differ with brands, though 9 out of 15 samples contain more than 90% Silicon. The main components of the analysed tempered glass samples are Silicon, Zirconium, Calcium, Strontium, Iron, Copper and many other minor elements (Yttrium, Hafnium, Manganese, etc). In the standard sample, the major elements are present in relatively lesser quantities except Strontium and Calcium that are present in significant quantities. Elements like Terbium, Holmium, Hafnium, Germanium, Gadolinium and Cobalt are present only in tempered glasses but are absent in the standard sample (soda-lime silicate). Their presence is a characteristic property of tempered glass and can be used for distinguish it from common soda-lime silicate glass. Silicon, Copper, Potassium, Iron and Zinc are present in both standard as well as the samples in varying quantities; however, potassium and iron are in relatively higher quantities in standard sample than in tempered glass samples. Elements like Terbium, Holmium, Platinum, Tin, Chromium, Germanium and Gadolinium, Neodymium, Gallium, Cerium, Phosphorus, Lutetium and Osmium are found in very minute quantities and each of these is not present in more than one sample. It may or may not be present in all the brands.

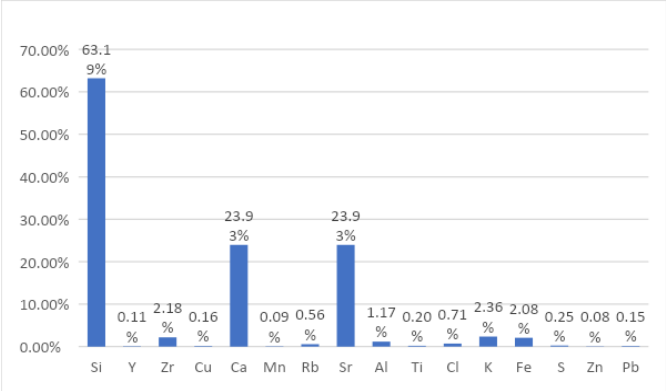

Figure 5. Elemental composition of the standard soda lime glass

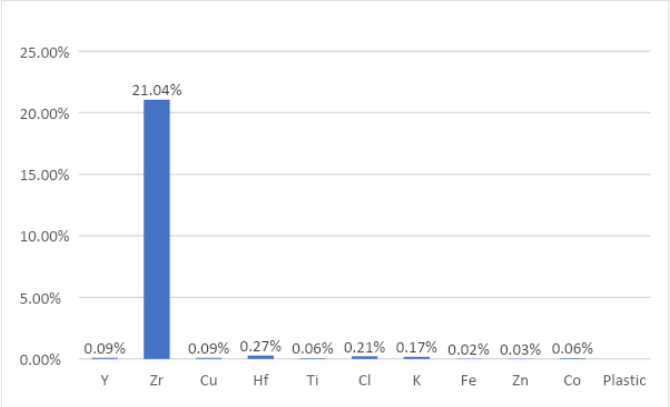

Figure 6. Elemental composition in a typical tempered glass sample

5. Conclusion and Future Scope

Glass fragments originating from the tempered glass screen protectors can be identified and distinguished from other type of glasses using Microscopic and Optical examination. Elemental profile analysis using ED-XRF also proves to be useful in distinguishing a glass as a tempered glass and may also be useful to discriminate among different brands. Hence this study aids in the analysis of tempered glasses that can be conducted when encountered in a crime scene. Broken/crushed tempered glasses which may be encountered at crime scenes have not been considered for analysis due to insufficient time. Only one type of glass was selected as a standard reference, however, other glasses like borosilicate glass, lead glass, optical glass etc., could have also been compared. Screen protectors for devices other than mobile

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phones such as laptops, smart watches can also be considered for analysis.

Data Availability
Data will be made available on reasonable request.

Conflict of Interest
The authors declare that they do not have any conflict of interest.

Funding Source
None

Authors' Contributions
Author-1 and author-2 did the conceptualization, formal analysis and experimentation, data collection, and wrote the original draft. Author-3 and author-4 were involved in developing the methodology as well as in the supervision and validation of the study. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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References

[1] J.M. Curran, T.N.H. Champod, and J.S. Buckleton, "Forensic interpretation of glass evidence," *CRC Press, United States,* **2000**
[2] K. E. Seyfang, K. Redman, R. S. Popelka-Filcoff, and K. P. Kirkbride, "Glass fragments from portable electronic devices: Implications for forensic examinations," *Forensic Science International*, Vol. **257**, pp. **442–452**, **2015.**
[3] D. A. Skoog, F. J. Holler, and S. R. Crouch, "Principles of Instrumental Analysis," *Cengage Learning, United States, 2017.*
[4] O. Ovide, R. Corzo, and T. Trejos, "The analysis of glass from portable electronic devices and glass accessories using µ-XRF for forensic investigations," *Forensic Science International,* Vol. **343**, pp. **111550**, **2023.**
[5] N Civici and Vataj, "Analysis of automotive glass of various brands using EDXRF spectrometry," *Rom Rep Phys,* Vol. **65**, pp. **1265-1274, 2013**
[6] M. Sharma, "X-Ray Fluorescence Analysis: Useful For Forensic Examination," *Journal of Forensic Sciences & Criminal Investigation,* Vol**. 1,** No. **1, 2016.**
[7] J Gelb, & X Yang, "Quantifying Tempered Glass Layer Compositions using Micro-XRF"
[8] T. Hicks, F. Monard Sermier, T. Goldmann, A. Brunelle, C. Champod, and P. Margot, "The classification and discrimination of glass fragments using non destructive energy dispersive X-ray µfluorescence," *Forensic Science International*, Vol. **137**, No. **2–3**, pp. **107–118, 2003.**
[9] R. D. Koons, C. A. Peters, and P. S. Rebbert, "Comparison of refractive index, energy dispersive X-ray fluorescence and inductively coupled plasma atomic emission spectrometry for forensic characterization of sheet glass fragments," *Journal of Analytical Atomic Spectrometry*, Vol. **6**, No. **6**, pp. **451, 1991.**
[10] C. R. Howden, R. J. Dudley, and K. W. Smalldon, "The Analysis of Small Glass Fragments Using Energy Dispersive X-Ray Fluorescence Spectrometry," *Journal of the Forensic Science Society,* Vol. **18**, No. **1–2,** pp. **99–112, 1978.**
[11] C. Martinez-Lopez, O. Ovide, R. Corzo, Z. Andrews, J.R. Almirall, & T. Trejos, "Homogeneity assessment of the elemental composition of windshield glass by µ-XRF, LIBS and LA-ICP-MS analysis.," *Forensic Chemistry*, Vol **27**, pp. **100384, 2022.**
[12] K. Rupert, M. Ho, & T. Trejos, "Study of Transfer and Persistence of Glass in a Mock Kidnapping Case," *JASTEE,* Vol. **8**, No. **1**, pp. **16-33, 2018**
[13] R. Corzo, T. Ernst, J. Insana, C. Martinez-Lopez, J. Webb, E. Haase and T. Trejos, "Evaluation of the performance of modern X-ray fluorescence spectrometry systems for the forensic analysis of glass," *Forensic Chemistry*, Vol. **31**, pp**. 100447, 2022.**
[14] A.T. Hamigah, P. Maheshwaran, D.B. Thilini Minthari and S. Niroshan, "Investigation on Properties of Fiberglass with Different Layers," *International Journal of Scientific Research in Physics and Applied Sciences,* Vol**.8**, No.**4**, pp.**07-12, 2020.**
[15] Boya Nagendra and K. Narasimhulu, "Physical and optical properties of Sodium Borotellurite glasses," *International Journal of Scientific Research in Physics and Applied Sciences,* Vol.**6**, No.**5**, pp.**105-110, 2018**

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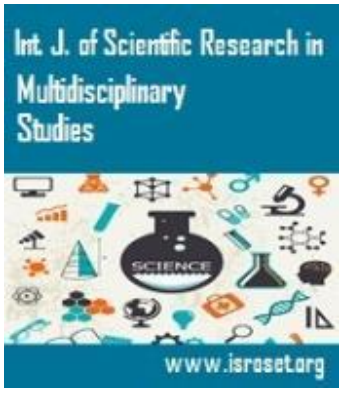

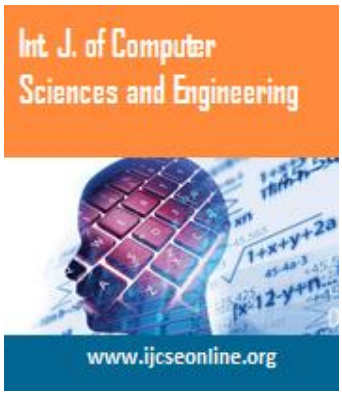

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