

ANALYSIS OF GLASS FRACTURE PATTERNS ON GLASS PANES

NUR IRYANI BINTI MOHD YUSOF

UNIVERSITI TEKNOLOGI MALAYSIA

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NUR IRYANI BINTI MOHD YUSOF

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To my beloved mother and father
Rosiah Binti Yahya and Mohd Yusof Bin Anang

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ABSTRACT

Glass is one of the most common and important evidence submitted to forensic laboratories for analysis. It is frequently encountered at crime scenes, particularly those involving motor vehicle accidents or burglaries. This study emphasized on the examination of the fracture patterns performed on different types of glass panes after broken by different type of impact objects, analysis of fracture features to determine direction of force and identifying of refractive index of glass as further analysis. Three types of glass panes (float, tempered and laminated) and four levels of breaking devices (hammer, bat, golf ball and stone either by throwing or using catapult) were used in the experiment. The results show that almost the whole float glass panes were shatters into sharp glass pieces after broken by all type of breaking devices. Then, tempered glass pane was broken with the whole glass panes shatters into small pieces of blunt granules when only hammer exerted on the glass, meanwhile, for other breaking devices were caused a scratch marks on glass surface. For laminated glass when broken by bat, throwing a stone and using catapult, almost the whole of glass panes were remains intact on its interlayer film and got some splinters from point of impact were flying out. Meanwhile, fracture patterns on laminated glass pane when broken by hammer produced a cone or crater after striking. However, impact objects used to break those types of glass panes are not really reliable to be distinguished. This is because the fracture patterns on glass panes obviously differ by its types of glass only. When a pane of glass is broken by an impact, majority of the broken fragments will fall in the direction of the force, which is on the side of the glass panes opposite direction of the application of force. A determination of the direction of force in breaking a glass pane can be determined by the direction of the rib marks. As the impact occurs, concentric fractures form around the impact and interconnect with radial cracks to form triangular pieces. The edge of each triangular piece has visible stress lines that describe the direction of the blow. The refractive index of each type of glass was determined by GRIM 3 equipment which produce results of refractive index for float glass panes are about 1.5200; tempered glass panes are about 1.5181 and, laminated glass panes are about 1.5188.

ABSTRAK

Kaca adalah salah satu bahan bukti yang penting dan biasa dihantar ke makmal forensik untuk dianalisis. Ia sering dijumpai di kawasan berlakunya jenayah, terutama apabila melibatkan kes kemalangan kenderaan bermotor ataupun pecah rumah. Kajian ini menumpukan kepada pemeriksaan bentuk retakan yang terhasil pada jenis tingkap kaca yang berlainan selepas dipecahkan oleh jenis objek yang berbeza, analisis sifat retakan untuk mengenal pasti arah daya yang ditujukan dan identifikasi indeks biasan kaca sebagai analisis tambahan. Terdapat tiga jenis tingkap kaca (terapung, tahan lasak dan berlamina) dan empat peringkat alat pecahan (tukul, pemukul, bola golf, dan batu sama ada secara lontaran atau menggunakan lastik) telah digunakan dalam eksperimen ini. Keputusan yang diperoleh menunjukkan hampir keseluruhan kaca terapung berkecai menjadi serpihan kaca yang tajam selepas dipecahkan oleh semua jenis alat pecahan. Seterusnya, kaca tahan lasak pecah dengan keseluruhannya berkecai menjadi serpihan butir-butir kaca yang kecil apabila tukul digunakan, manakala, untuk alat pecahan lain telah menyebabkan tanda calar pada permukaan kaca. Bagi kaca berlamina yang telah dipecahkan oleh pemukul, lontaran batu dan menggunakan lastik, hampir keseluruhan kaca masih melekat pada filem lapisan dalam dan terdapat juga serpihan kaca yang kecil dari permukaan hentaman tercampak keluar. Kemudian, corak retakan pada kaca berlamina apabila dipecahkan oleh tukul telah menghasilkan bentuk kon atau kawah selepas hentaman. Walau bagaimanapun, objek hentaman yang digunakan untuk memecahkan kesemua kaca ini diragui untuk dibezakan. Hal ini adalah kerana corak retakan yang terbentuk pada tingkap kaca sangat jelas berbeza mengikut jenis kaca sahaja. Apabila kaca dipecahkan dengan hentaman, majoriti serpihan kaca akan jatuh mengikut arah daya dikenakan iaitu pada bahagian tingkap kaca yang berlawanan dengan aplikasi daya dikenakan. Penentuan arah daya dikenakan untuk memecahkan kaca boleh ditentukan daripada arah tanda rusuk. Sebaik sahaja hentaman berlaku, retakan sepusat terbentuk di sekeliling hentaman dan menghubungkan dengan retakan jejarian untuk menghasilkan kepingan bentuk tiga segi. Pada bahagian tepi setiap kepingan berbentuk tiga segi boleh dilihat garisan tekanan yang mana dapat menentukan arah pukulan objek. Indeks biasan bagi setiap jenis kaca ditentukan dengan menggunakan peralatan GRIM 3 yang mencerpakan keputusan indeks biasan untuk tingkap kaca terapung adalah 1.5200, tingkap kaca tahan lasak ; 1.5181 dan tingkap kaca berlamina pula adalah 1.5188.

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LIST OF ABBREVIATIONS

#	-	Number
%	-	Percentage
°C	-	Degree Celcius
AOAC	-	Association of Official Analytical Chemists
ASTM	-	American Society for Testing Materials
CaO	-	Calcium Oxide
g/cm ³	-	Gram per centimetre cube
GRIM	-	Glass Refractive Index Measurement
m	-	Metre
mm	-	Millimetre
MSG	-	Malaysian Sheet Glass
Na ₂ O	-	Sodium Oxide
nm	-	Nanometre
PbO	-	Lead Oxide
PVB	-	Polyvinyl Butyral
RI	-	Refractive Index
SEM	-	Scanning Electron Microscopy
SiO ₂	-	Silicon Dioxide
UV	-	Ultra Violet
V	-	Relative Dispersion

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Glass can be found in most localities. It is produced in a wide variety of forms and compositions, which differentiates the properties of their material. This will give evidence when it is broken during a commission of a crime. There are automobile glasses, broken in accidents, shattered by gunshots, or just caved in with a baseball bat or hammer by strangers. Broken glass fragments ranging in size from large pieces to tiny shards may be transferred to and retained by nearby persons or objects.

The behavior of glass during loading and fracture is decisively affected by their structure, which depends on both the composition and the manufacturing. A deformed or indented frame, in which glass panes was built in, indicates that the failure was caused by force acting on the frame. Conversely, if only the glass was damaged but no other parts, it is probable that the glass was broken by force acting on it alone, or by thermal or residual stress. Any observation or information related to the fracture and its possible cause must be carefully recorded.

The forensic examiner may be able to analyze fractured window panes and determine the direction of an impact and the amount of force applied to them, suggesting what actually happened at the scene. For example, it is often important to establish whether a window was broken from inside or the outside. In the case of burglary, the window would have been broken from the outside.

1.2 Statement of the Problem

Glass fracture patterns are unique; and these fractures are caused by an impact either high-velocity or low-velocity projectiles, or glass cutters, which each of them can be distinguished. Laboratory examination of recovered shards may reveal the direction of breaking forces or the type of projectile and its angle of penetration. Pieces of glass after incident may be fitted together such that a recovered fragment can be identified as it had been broken from a specific pane to the exclusion of all others. For such a case, this study is undertaken to differentiate the fracture patterns on different type of glass panes which usually broken during commission of crime. Moreover, refractive index of glass is different to each other according to their chemical composition from different type of glass. Therefore, refractive index of glass also needs to be determined for the purpose to link sample glass fragment to origin glass.

1.3 Objectives of the Study

The objectives of this study are:

- i) To compare and analyze the fracture of the glass focusing on glass panes fracture patterns with varying different types of glass panes and object impacts.
- ii) To identify glass panes fracture patterns as to direction of the breaking force.
- iii) To determine the refractive index of glass using Glass Refractive Index Measurement as subsequent analysis in this study.

1.4 Scope of Study

Determination of glass panes fracture patterns related to forensic glass analysis is studied. In this study, the characterization and assessment of the significance of fracture features in glass panes are observed through microscopic and macroscopic examination which is important in forensic investigation. Different types of glass panes which are float, tempered and laminated glass as well as different type of object impact which usually used during commission of crime prepared for this study. The refractive index for glass is determined using GRIM (Glass Refractive Index Measurement) as further analysis.

1.5 Significance of the Study

Fracture patterns in a piece of glass reflect the nature of the glass and the direction of travelling and velocity of the breaking object. Glass fracture examinations undertaken to determine the direction of force and the presence of a physical match depend upon careful evidence collection and packaging. Besides, broken and shattered glass fragments that are produced in the perpetration of a crime can be used to link a suspect to that crime scene. Thus, this study is embarked to assist the police or forensic investigators to analyze fracture pattern of glass panes in order for them to reconstruct the sequence of events that occurred when the crime was committed.

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