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Research Article

Investigation of Forensic Glass Fractography made by Different Ammunition

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Abstract

At the scene of crime, investigating officer/crime scene manager or forensic glass examiner often encounters the shooting at inanimate target such as glass, door, window panes, windows of an automobile etc. Now a day, window panes are coated with transparent, but colored sun control coated film for fancy purpose as well as to maintain inside privacy in the houses/offices or in an automobile. These films are easily available in the open market. The main aim of this experiment is to study the fracture characteristics of sun control coated film on various thickness of windowpane by using regular jacketed, non-jacketed and semi jacketed ammunitions manufactured in an Indian Ordnance factory, India. The film-coated window panes were kept at front and away from the muzzle end.

The experimental findings of types of bullets on sun control coated film windowpane were completely different. At the crime spot, investigating officers may confuse if the actual shooting took place through film coated glass panes and simulation of crime scenes are not correctly carried out in the laboratory. The detailed findings of this fractography study of the sun control coated film windowpane by .315", AK-47, .303" rifles and 9 mm regular and country made pistol may be efficacious to forensic community.

Keywords: Crime scenes; Ammunition; Rifle; Sun control coated films; Glass fractography

Introduction

In criminal investigation, it is well known fact that, intermediate targets may influence the distribution of the projectile fragments in case of fatal injuries by regular rifles. A variety of objects like glass, ceramics, window screens, vehicles, walls and articles of clothing, served as intermediate targets for bullet may cause ricochet bullet or it may become secondary missiles.

In literature, various methods are available for examination and comparison of glass fragments. The variations in size of glass sheet have a significant influence on the resultant fracture described by [1-3] estimated remaining velocity of bullets fired through glass plates [4]. Interpreted the mode of glass fracture arise by bullet impact, in terms of dynamical stress field [5]. Observed that the perforation craters produced on glass had always a well defined shape with more or less constant semi angle which were independence of the projectile caliber, velocity and thickness of the target. Hackle marks are also found on the roughened surface surrounding the fracture hole. A small arms bullet is Cylindroconical in shape and endowed with a high rate of spin. When such bullet traverses through a glass target it makes considerable difference and modifies the basic values of various parameters as reported by [6-7]. The implications of forensic problems of the manner in which a flat glass surface break was described by [8-9] laboratory followed their reports of evidence of fractured glass in criminal investigation [10]. Described examination of glass fracture from a forensic point of view. A detailed discussion on the nature of glass fracture as an aid in the solution of forensic issues was described by [11]. Engineering aspect of glass fracture was reviewed by [12-13].

No studies were reported on fracture of sun control coated thin film window pane in forensic point of view. In this paper attempts were made to analyse the fracture of glass of sun control coated thin film windowpane as target fired by .315 rifles, 303 rifle, AK47 rifle, 9mm pistol and an improvised pistol using their respective ammunitions and compared their result for collaborative analysis. This study will help forensic examiners ascertain the nature of glass fragmented.

Figure 1: 8 mm bullet entry hole on glass sheet.

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Table 1: i) Thickness of windowpane: 4 mm. ii) Distance from glass target to muzzle end of weapons: 2.44 meter.

Shot Number	Firearm used	Initial velocity of firearm m/sec.	Remaining velocity of firearm m/sec	Diameter of hole obtained after firing in millimeters
1	.315 Rifle	722.98	615.08	15.748
2		724.20	609.60	17.221
3		722.37	619.96	16.256
4		722.07	613.25	16.662
5	.303 Rifle	783.03	683.66	13.817
6		784.55	676.35	13.843
7		771.45	666.90	11.404
8		769.92	664.16	14.224
9	Ak-47 Rifle	714.14	564.49	17.094
10		710.79	569.97	16.459
11		713.23	566.62	16.002
12		712.31	574.85	14.097
13	9mm Pistol	373.68	269.44	13.538
14		373.38	257.25	14.147
15		374.29	258.77	14.630
16		371.55	249.63	11.049
17	Improvised pistol	438.91	178.38	13.970
18		472.44	218.31	19.431
19		439.82	170.68	12.192
20		454.76	185.01	11.353

Table 2: Firearm-Cartridge combinations used for firings.

Firearm	Cartridge	Bullet weight (gms)
.315 rifle, RFI, 1973, Sr.No. 94 AB 2832	8 mm,soft nose, K.F.,01	15.34
.303 Rifle No.III*, S.No.F507FTS	.303,Ball,MK-7,K.F.	11.3
AK-47 Rifle Sr.No. AFN-1198,1996	7.62x39 mm,322,74	9.5
9mm Pistol, Browning MK-I, 1203	9 mm, ball, auto, K.F.,	7.4
Country made pistol (exhibit)	8 mm, soft nose,K.F.,01	15.30

Table 3: Data on the Ballistics Characteristics.

Sr.No.	Caliber of Bullet	Type jacketed/soft nose/unjacketed	Shape of Nose	Length in mm	Weight in grain	Diameters in mm
1	8 mm	Soft nose	Round nose	31.49	236.7	8.102
2	.303"	Jacketed	Sharp pointed	32.25	174.3	7.899
3	7.62x39 mm	Jacketed	Sharp pointed	29.46	146.6	7.721
4	9 mm	Jacketed	Flat pointed	14.73	114.1	9.220
5	8 mm	Soft nose	Round nose	31.49	236.7	3.530

Method and Materials

A specially designed metal frame was used to fix the 1 feet x 1 feet sun control coated thin film windowpane. The proposed frame was kept perpendicular to the muzzle end of the weapons. Initial and remaining velocities of each firearm were measured by using electronic timers developed by Electric Corporation of India Limited, Hyderabad (Table 1). The arrangement of firing is shown in Figure 1. The test firings are done as per Table 1, 2, 3. The data as shown in Table 1, .315" sporting rifle, .303" rifle, Ak-47 rifle, 9 mm semiautomatic pistol and country made pistol with a combination of 8 mm (soft nose bullet), .303" (fully jacketed bullet), 7.62x39 mm (fully jacketed bullet), 9 mm (fully jacketed bullet) and 8 mm (soft nose bullet) respectively, were fired and simultaneously their muzzle (initial) and remaining velocity of each firearm were measured. The details are shown in Table 2 and 3. The detailed fractured characteristics present on glass sheet produced by each firearm have been briefed in Table 4 and 5.

Result and Discussion

Experimental results reveals that the fracture mist, mirror, Wallner lines, rib marks and hackle mark lines are very important

Table 4: Type of glass: Sun control coated film.
i) Thickness of windowpane: 4 mm
ii) Glass position of target: Build in supported

Firearm used	.315" rifle	.303" rifle	Ak-47 rifle	9mm pistol	Improvised pistol
Mean loss of energy in joules	34.59	24.74	27.58	20.17	64.87
Radial fracture: A group of shaped radiating lines originate from the point of impact in all direction	P	P	P	P	P
Concentric fracture	P	P	P	P	P
Rib marking on edge:	P	P	P	A	A
Hackle marking on edge: These marks are present near kept at impact with more at edge zone	P	P	P	P	A
Mirror Surface: Microscopic crack branching	P	P	P	P	A
Mist zone edge:	P	P	P	P	A
Wallner lines: Series of marks concave towards the fracture origin	P	P	P	A	A
Heartzean lines: Case black presently absent	P	P	P	P	A
Petal pattern around the hole	P	P	P	A	A

Note: P indicates present & A indicates absent.

Table 5: Data on fracture characteristics of various firearms.

Sl. NO.	Weapons used	Thickness of glass pane (Inches)	Diameter of mirror zone (Inches)	Diameter of mist zone (Inches)	Position of sun control film on glass pane
	.315"/8mm rifle	1.99	15.16	22.65	No film
2.	=do=	1.96	16.38	19.30	No film
3	=do=	1.96	13.94	35.66	No film
4.	=do=	2.95	28.93	35.30	No Film
5.	=do=	2.95	27.99	32.68	No film
6.	=do=	2.95	30.96	34.64	No film
7.	=do=	3.44	37.10	35.89	No film
8.	=do=	3.44	37.10	32.63	No film
9.	=do=	3.44	37.89	52.47	No film
10.	=do=	3.93	37.59	53.18	No Film
11.	=do=	3.93	43.30	52.67	No film
12.	=do=	3.93	48.26	68.02	No film
13.	=do=	5.90	46.91	64.71	No film
14.	=do=	5.90	45.99	67.13	No film
15.	=do=	5.90	50.59	20.44	No film
16.	=do=	3.93	50.39	50.41	Film at muzzle side
17.	=do=	3.93	58.67	13.41	Film at muzzle side
18.	=do=	3.93	56.76	38.02	Film at muzzle side
19.	=do=	3.93	65.48	38.50	Film away from muzzle side
20.	=do=	3.93	80.56	39.92	=do=
21.	=do=	3.93	84.98	15.31	=do=
22	AK 47 Rifle	3.93	38.98	16.48	No film
23	=do=	3.93	39.34	17.39	=do=
24	=do-	3.93	38.88	17.17	=do=
25	AK 47 Rifle	3.93	14.42	14.09	Film at muzzle side
26	=do=	3.93	40.28	14.75	Film at muzzle side
27	=do-	3.93	38.10	20.14	Film at muzzle side

28	AK 47 Rifle	3.93	41.88	22.52	Film at away from muzzle side
29	=do=	3.93	41.42	21.08	Film away from muzzle side
30	=do-	3.93	45.31	11.17	Film away from muzzle side
31	9mm Pistol	1.96	8.63	12.64	No Film
32	=do=	1.96	8.89	11.73	No film
33	=do-	1.96	9.65	19.45	No film
34	9mm Pistol	3.99	38.48	18.31	No Film
35	=do=	3.99	35.61	18.26	No film
36	=do-	3.99	37.94	22.25	No film
37	9mm Pistol	3.99	39.16	19.96	Film at muzzle side
38	=do=	3.99	38.96	19.40	Film at muzzle side
39	=do-	3.99	36.47	22.73	Film at muzzle side
40	9mm Pistol	3.99	42.11	22.17	Film away from muzzle side
41	=do=	3.99	40.51	21.36	Film away from muzzle side
42	=do-	3.99	44.80	21.41	Film away from muzzle side
43	Improvised Pistol using 8mm cartridge	3.99	46.86	21.37	No film
44	=do=	3.99	46.32	23.72	No film
45	=do-	3.99	46.53	23.62	No film

clues to investigate the fracture of origin and crack propagation direction of flat glass as well as the fundamental interpretation of the fracture.

When jacketed and semi jacketed projectiles pass through an ordinary windowpane, they distribute up to a long distance from the penetration hole. The fractures produced by firearm projectile vary from those developed by blunt impact, irrespective of energy. The typical manifestation of a high-energy projectile impact on sun control coated thin film windowpane is the formation of a crater along with main hole. The craters generated as a result from the impact of a projectile like .315"/8 mm etc. may give important information concerning the type of projectile used.

It is observed, the crack branching of a bifurcation occurs only when the applied stress is sufficiently high. Present experimental study of .315" caliber sporting rifle gives such type of bifurcation which is absent in improvised firearm as no regular rifling are present in the barrel, which achieve less velocity. Hence, if the applied stress is low, fracture occurs without crack branching and the fracture of glass surface appears very smooth. Interestingly, keyhole effects are also found on the windowpane on the firings of improvised pistol. The characteristics of keyhole pattern are not present in regular firearm (Figure 1 and 2).

A smooth area obtained in thin-coated film called the mirror surface appears about the fracture initiating flow. This is bounded by the mist zone, which shows the beginning of microscopic crack-branching the inner mirror radius. Similarly the fracture surface area of sun coated thin film on glass sheet shows a highly rough area called the hackle region. The shape of the fracture mirror depends on the magnitude of the breaking stress, the stress distribution and on the fracture initiating point. Impact of bullets on windowpane

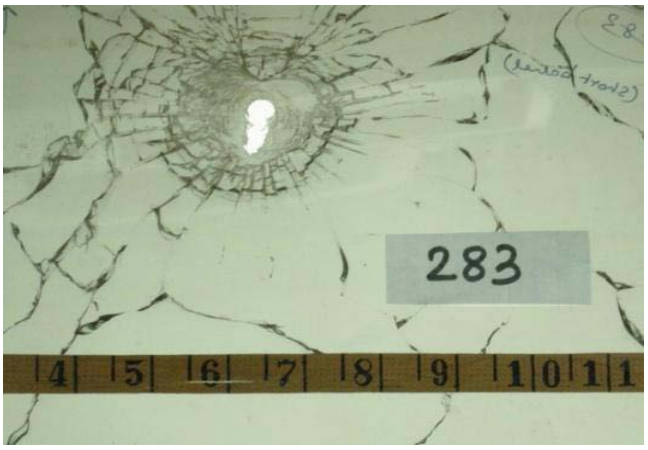

Figure 2: 8 mm bullet exit hole on glass sheet.

cause a windowpane fracture having characteristic features (Table 4) dependent on the velocity, firearms and angle of impact. Table 5 showed the data on fracture characteristics of various firearms in respect of mist and the mirror zone of fractured windowpane. The effect of high velocity on windowpane will exhibit around, clean hole, beveled occurring outward on the exit side if the sun control coated film is at the exit side. However, if the sun control coated film is at the muzzle end bevel pattern will not be exhibiting at the exit end. It is a unique pattern obtained on sun control coated thin film on the windowpane. It was observed that from the exit side, more or less circular pieces were removed by the bullet. It was also observed that a piece smaller than the bullet was first expelled followed by a secondary missiles.

It is revealed that there is no change in irregularity of the windowpane hole if the velocity of weapon changed up to a certain limit such as up to five meters from the study of the holes, it is observed that the concentric patterns around the hole emanate from the edge of the bullet hole which are formed early in the fracture process. Afterwards the radial fractures are created. These observations are very useful at place of occurrence [10]. Observed that the Beveling produced on the side opposite the side at which bullet strikes. The present findings are also same in case of high velocity weapons on windowpanes.

By examining the cracks produced from a number of bullet holes in sun control thin film coated on windowpane it is possible to determine the ways in which fracture were produced. Table 1 data shows that the diameters of holes obtained after firing through window panes vary from weapon to weapon. Table 2 shows the firearm cartridge combinations used for experimental firing on same thickness of windowpane 4 mm. Data on the ballistics of bullets such as caliber, type and their dimension along with weight are shown in Table 3.

Table 4 reveals the various phenomena of glass fracture by the firing of different caliber of weapon on sun control coated thin film windowpane. Fracture of glass produced by improvised pistol is different as compared to other regular firearms.

Our finding agrees with the theory of Beveling phenomena at the exit side [10]. It is also observed that the radius of mist and a mirror zone around the bullet hole can be related with respect to the energy of impact, combination of firearm-ammunition, range of firing and tensile stress. This study showed that the mirror surface region, Wallner lines frequently appear as a result of the interaction between elastic waves produced from some irregularities in the surface. Wallner lines are a series of marking concave towards the fracture origin. Hence, these lines may be useful to indicate the direction of crack propagation.

Impact of bullet on sun control coated thin film windowpane observed that, the series of cracks radiate in a star shaped pattern which are radial fractures originating from the point of impact, but in improvised pistol firing number of regular concentric lines are not found and a few numbers of radial lines are found on the glass sheet. On the examination of fracture, edge rib marking are observed in all cases. In radii fractures rib markings are distributed perpendicular to the surface of impact and tangentially with the opposite surface. In the concentric region, these markings are at right angles to the impact surface. Hackle marks are also observed at right angles to rib markings, more than hackle markings are found nearer to the point of impact. They traveled in the direction of movement of the fracture.

Conclusion

Various phenomena are given by bullet impact of different firearms on sun control coated thin film, window panes, which are absent in glass panes without coating. Fractures, obtained on film-coated window panes by an improvised gun are not similar as other regular firearms. These observations may be helpful to forensic glass examiner/scientists or crime scene manager at scene of crime. In general, crack does not immediately change its direction when an applied force inclined to the surface of a running creek is applied. It was also observed that the mirror surface region, Wallner lines are a series of markings concave towards the fracture origin. Hence, these lines can be applied to indicate the direction of crack propagation.

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