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Examination of dispersion pattern of GSR deposited on cloth target by 0.315”/8mm country made pistol at close firing range

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Abstract

The examination of Gun Shot Residue has become obligatory in forensic examination of firearm.GSR helps in the easy disposal of cases where the range of firing is to ascertain. GSR may use to identify the entry and exit holes and it also helps in determining whether or not a person has discharge the firearm or not. The author tried to focus attention on the examination of the dispersion pattern of GSR particles deposited on cotton cloth target at different shooting distances (4inch, 8inch and 12inch). Ten different .315”/8mm calibre of country made pistols were used and ammunition (KF,Khadki factory, Pune) were used for test firing. All test firing was performed at firing room of ballistic division of CFSL/CBI/New Delhi. The results showed that GSR particle produce on cotton cloth by .315”/8mm Country made pistol using .315”/8 ammunition generates high amount of larger GSR particle which were almost completely burnt particle.The nitrite residue was continued using modified griess test that revealed a mean particle size of 3.2µm with spherical shape. As the range increases from 4’” to 12”, GSR particles produces were small in amount. Whereas SEM microscope of GSR particle directly from .315”/8m calibre of CM pistol generated irregular cluster of group gains. Sodium rhodizonate test was also applied for detection and the presence of lead residue around the bullet hole.

Keywords: GSR, Pistol, Target, Firing Range.

Introduction

During investigation of the incident involving the use of firearms, Forensic expertise can provide key elements for the count to reach an opinion, whenever country made firearms used in crime, particular attention can be drawn to evaluate the issues associated with country made firearms and related evidences such as GSR. Before reaching at the scene of crime, it is the first responsibility of the investigating officer to secure the scene of crime.GSR is also known as firearm discharge residue or cartridge discharge residue. GSR is formed when a cartridge is fired from the firearm. GSR plays a vital role in the investigation of scene of crime (Gallusser,Bonfanti, &Schutz, 2002; Kersh, Childers, Justice, Greg, 2014).When a gun is being fired, it releases flame, smoke, burnt and unburnt powder particles along with the bullet from the muzzle end of the weapon. In addition, metallic lead & other elements contained in the bullet, case and primer. One expelled from the muzzle of firearm (MulaniKhudbudin at all 2016). These particles create a circular pattern, when come out from the muzzle end of the firearm. The estimation of firing distance is based on the bullet hole and the dispersion pattern of GSR around the bullet hole. The diameter of the particles of Gun Shot Residue are often formed in the range of 0.1-10µm and upto 55µm and above (Basu, 1982; Wolten& Nesbitt, 1980).The estimation of shooting distance was first made based on the direct and visual examination on the target and then treat with specific chemical regents (james, S.H. and ordby;2005). Dispersion pattern of GSR is very sensitive and investigative too, because powder residue pattern may vary significantly. Powder residue path does not depend on the length of the barrel but also change with the change in the range of firing and also change with change in primer, powder type and the type of propellant.

In this study, author tried to estimate the firing distance based on dispersion pattern of GSR and the analysis elemental composition of GSR was carried out using SEM/EDX. It is perceptible that collecting cloth evidence bearing GSR has more potential for providing implicate evidence in some cases then bare hand sampling. GSR retained on clothing and are considerably long then skin surface resulting in a high probability of their detection and identification from that source. Another chemical used to estimate the firing distance is known as sodium rhodizonate test which is used as a spot test for lead residue. These chemical test were used in the study to restore insufficient interpretation of GSR pattern

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from visual examination by the naked eye as well as microscope.

Materials and Method

The test firing was done in an indoor shooting range of ballistics division of CFSL/CBI/NEW DELHI using .315"/8mm calibre of CM pistol. The main objective of test firing is to estimate the firing distance from muzzle and to the target on the cotton cloth. The ammunition used of Khadki factor, Pune. Test firing was done at 4",8" and 12" distance. These close distance were choosing because nitrate and other GSR element were only effectively detect at close range(Jefery,1998). Cotton cloth target were used for the firing target of size 25×25cm(app.). The cotton cloth target is placed over card board of size 30×30cm(app.), and then stapled over it. The target was fixed to the recovery box, which is 150cm above from the ground. The cotton cloth was not stretch but pulled tightly enough to eliminate wrinkles. The stand bearing the clothes was the position at different distances from the shooter. A Canon EOS 1200D (Made in japan) digital camera was used for photographing the images. After that dispersion pattern of GSR was calculated by visual method by taking the outer radius of the circle (outer radius of the circle was taken from the centre of the circle to the outer dispersion line) and then inner radius of the circle (inner radius was taken from the centre of the circle to the inner dispersion line) and put the formula of area of circle ($A = \pi r^2$). By using this formula, we can find out the dispersion pattern area of the Gun Shot Residue. Atlest 10-10 times shooting were tried on the target surface from there different ranges. The steps of all experiment and all test firing were performed by the specialised Ravinder Chauhan. Each distance was repeated ten-ten times so, that modified griess test and sodium rhodizonate test (SRT) could be applied on separate cloth target bearing the GSR. After calculating the dispersion pattern area of the Gun Shot Residue, the sample is further proceeding for the instrumental analysis. The Scanning electron microscope, model Zeiss EVOMA10 equipped VEGA 3LMU/EDX (Energy Dispersive X-ray) was used for detection of GSR particles and its morphology

Modified Griess Test

For modified griess test, fresh griess reagent was prepared with 0.5g of sulphanillic acid and 0.2g of α-napthylamine. Put them into two separate beaker containing 70ml of water and heat until they mix completely. After mix, cool them and add 30ml of acetic acid. Then 1:1 ratio of α-napthylamine and sulphanillic acid taking into a beaker and put the solution on filter paper. Then the sample was placed face down on the filter paper and pressed on the layers. The cloth item was then separated from the filter paper. Pink colouration of the paper indicates the presence of nitrite residue.

Sodium Rhodozinate Test

For sodium rhodozinate test, the test area was initially sprayed with the saturated solution of sodium rhodozinate. The solution was prepared by dissolving a small amount of sodium rhodozinate in 100ml of water to form a saturated solution. After that, the same are washed away and then sprayed with the buffer solution. Blue colour appeared indicates the presence of lead.

Result

Instrument

SEM (Scanning Electron Microscope) model ZEISS quanta 200F with XJ Microscope control software and EDX (Energy Dispersive X-ray) detector model oxford instrument X-MAX were employed for morphological and elemental composition of GSR particles.

A. SEM/EDX Analysis

SEM was employed to analysis the morphology and characteristics of Gun Shot Residue particles. Sample size was cut near the bullet hole which contained high amount of GSR Particles of size 1X1 cm (app.). Stubs was properly clean with ethanol. Aluminum tape was cut & stick on the stub properly with the help of forceps, so that sample was adjusted on the stub. The stubs was placed in coating chamber for two hours. The analysis was done in high vacuum mode using 1X1 mm of gold and palladium coating. So, that cloth target do not get destroyed. It was adjusted at different magnification for proper microstructure image of GSR particle as well as percentage composition of elements which are present in GSR sample

C. Analysis of Examination Result

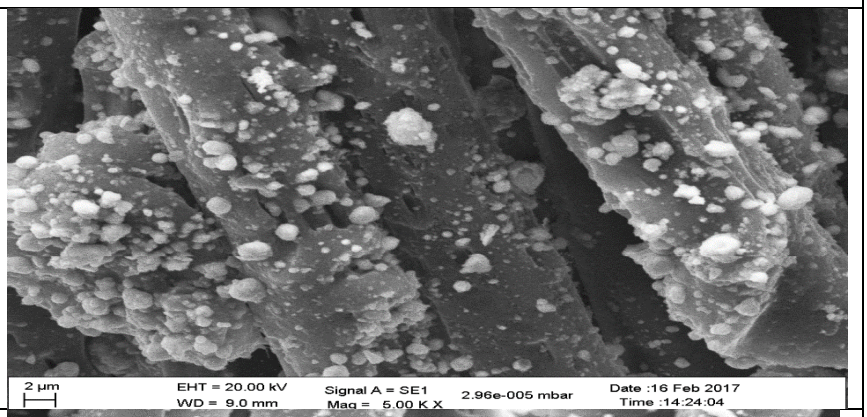
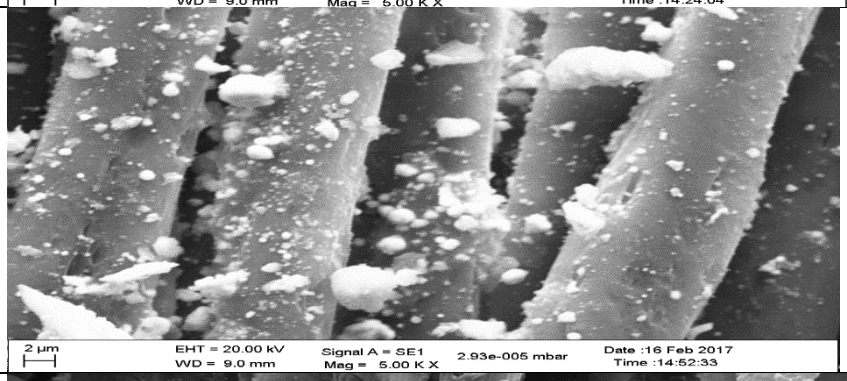
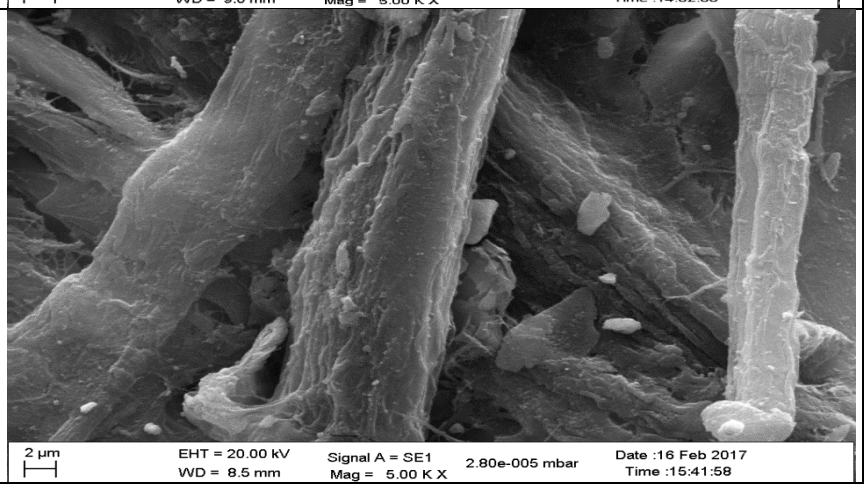
1. Visual Examination Analysis

The estimation of shooting distance was first made based on the visual examination on the cotton cloth target. The dispersion pattern was somewhat rough circular. The dispersion area was calculated by taking outer radius (radius was taken from the centre of bullet hole to the outer dispersion line), then area of circle was calculated by using the formula $A = \pi r^2$. By using this formula, the area of dispersion pattern of .315"/8mm caliber of country made firearms was calculated. It will help in estimating the range of firing and caliber of country made firearms.

RANGE	AREA OF DISPERSION PATTERN OF .315"/8MM
4"	5.7cm X 5.9cm(app.)
8"	8.2cm X 8.9cm(app.)
12"	15.5 X 16.2cm(app.)

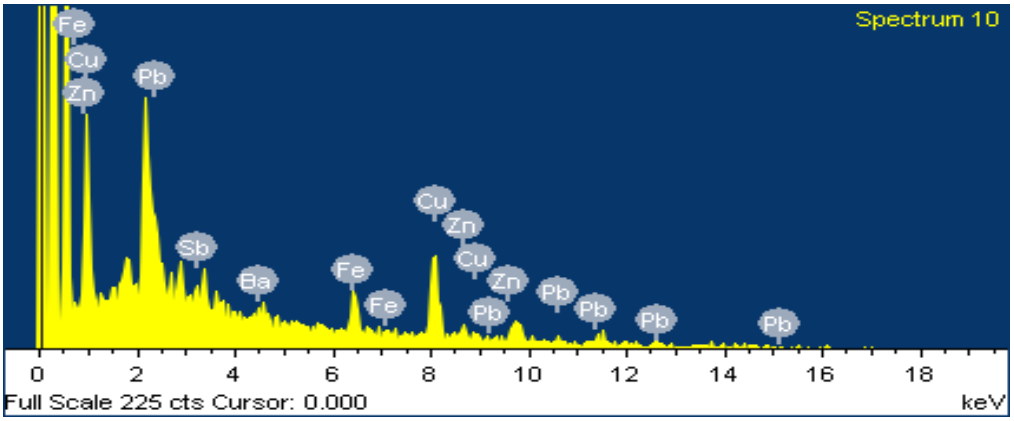
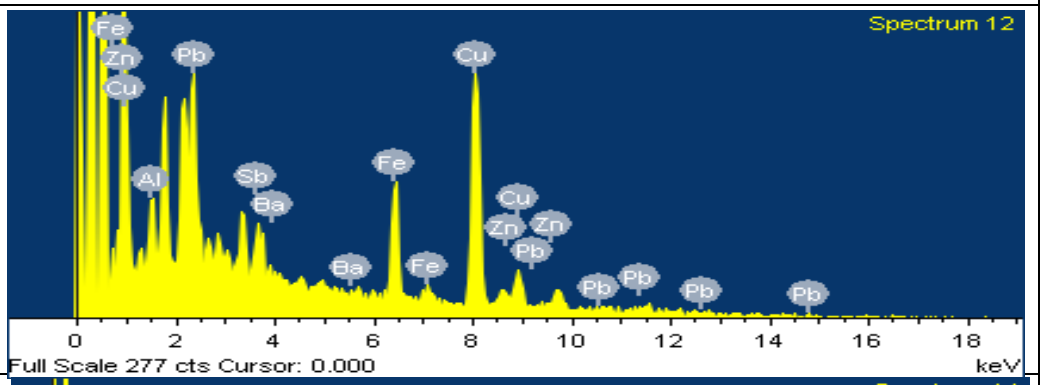
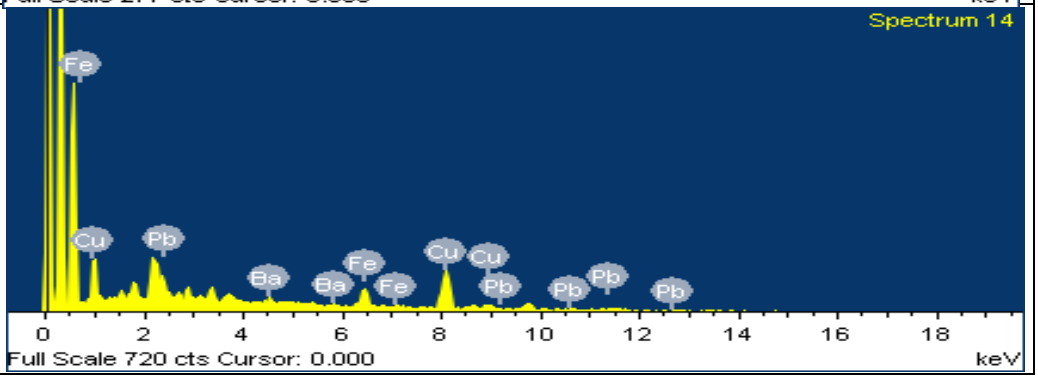
2. Scanning Electron Microscope Analysis

SEM was carried out to determine the morphology and microstructure of GSR. EDX was carried out to determine the elemental composition and percentage composition of GSR. Examination of GSR Particles from .315"/8mm country made pistol, using ammunition KF (Khadki factory, pune) ammunition, it is found that, more number of particles of GSR observed at 4" distance, as the range increases, the no. of particles decreases. The particle size of GSR increases as the range of firing increases. The particles size of GSR at 4" distance is about 1.6µm with somewhat spherical in shape. At the distance of 8", the particles size is about 2.1µm with roughly spherical in shape. At the distance of 12", the particles size of GSR is about 2.8µm with irregular spherical shape.

RANGE	.315"/8MM
4"	
8"	
12"	

Energy Dispersive X-rays Analysis

Energy Dispersive X-rays was carried out to determine the elemental composition and percentage composition of Gun Shot Residue.

RANGE	.315”/8MM
4”	
8”	
12”	

Observation of SEM/EDX

.315”/8mm Calibre: Lead, Barium and Antimony was observed from 4” to 8” range but at 12” range Lead and Barium was absent. It is found that antimony travel upto 10” because of their low atomic no. and low molecular weight. Their composition percentage of antimony in cartidge is about 8-10% but the composition percentage of lead in cartridge is about 60-70%.

Elements RANGE	LEAD	BARIUM	ANTIMONY
4”	15.2%	8.4%	4.3%
8”	10.8%	4.3%	1.2%
12”	7.2%	1.2%	--------

Conclusion

In this study we demonstrate the methods for determination of muzzle-to-target distance based on GSR distribution and GSR pattern. The test firing was carried out at 4", 8" and 12" distances. The dispersion pattern area was calculated by using the formula of area of circle. The GSR was analyzed by SEM/EDX. Information gained from this study can be used to estimate muzzle to target distance for reconstruction of shooting distance up to 12 inch. It can also help to identify the calibre of firearm. SEM micrograph study revealed the geomatrical shapes of GSR particles and EDX study revealed the composition percentage of elements generated from the .315"/8mm calibre of country made pistols & .315"/8mm and anmmunition. This study will help the forensic exerts to dispose off the cases, where range of firing is to ascertain when countrymade firearm were used in the crime.

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