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## Identification of bullet holes by scanning electron microscope - A case study

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### ABSTRACT

In all firearm cases ballistics examination are conducted on various physical evidences like fired cartridge case, bullet, firearm, GSR from shooter, victim's body and apparels to establish the crime and criminals beyond doubt. Further, with available data from scene of crime could help to reconstruct various aspects of the firing cases. In one case, there was sudden clash between two groups on a petty matter as a result, cross firing from both the groups resulted in death of one person and injuries to some police personnel. In the course of investigation in this case, different firearms, wearing apparels, cartridges and fired bullets seized could help to conduct forensic ballistics examination coupled with scanning electron microscopic analysis of GSR. The examination of GSR found on the body of the garments could undoubtedly identify the cause of bullet holes.

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### KEYWORDS

Bullet hole;  
Firearm;  
GSR;  
Scanning electron  
microscopy with associated  
energy dispersive  
spectrometry (SEM-EDX).

### INTRODUCTION

In principle, gunshot residues abbreviated as GSR is composed of burnt and unburnt particles produced when cartridges are fired from the firearm<sup>[1,2]</sup>. When a gun is fired, particles of extended gunpowder often blow back and deposited onto the hand and body of the shooter. These particles could be collected with stubs / adhesive lifts and then could be analyzed using a modern technique known as SEM-EDX (Scanning Electron Microscope with associated Energy Dispersive X-ray Spectrometry). The unique elemental composition and characteristic spherical shape of GSR are usually identified using SEM/EDX which helps in the identification of a single GSR particle in non-destructive way

and gives a high selectivity unparalleled by any bulk analysis methods. SEM is an effective method not only to detect GSR but also it can estimate the size and number of elemental particles<sup>[3,4]</sup>. Based on the analysis of the elemental composition of micro particles present on the lifts / stubs, it could be ascertained about the presence of GSR. As the GSR particles travel forward a few distances only, its presence at varying distance could further help to determine the proximity of firing. The GSR analysis is not only helpful in identifying the ammunition used, but also to identify the firearm / cartridge case / shooter/ bullet holes on clothing.

The aim of this work is to ascertain the cause of suspected bullet holes in the seized garments by SEM/EDX analysis.

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### EXPERIMENTAL

The investigating agency in this case sent firearms, live ammunitions, fired cartridge cases for forensic ballistics examination. In addition, the wearing apparels of the deceased having suspected bullet holes were received for examination to ascertain the presence of GSR and type of firearm used to cause such bullet holes on the garments. Considering trace quantity of GSR present, the SEM-EDX study was ideal for detection of the GSR. A scanning electron microscope (Carl Zeiss, model: S-1430 VP) was used for this study.



Figure 1: SEM of the unaffected control area of the garment

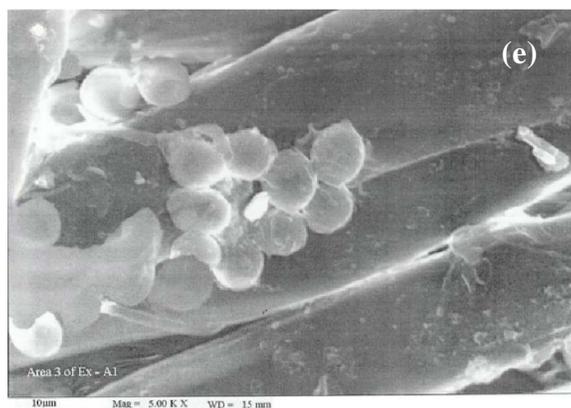
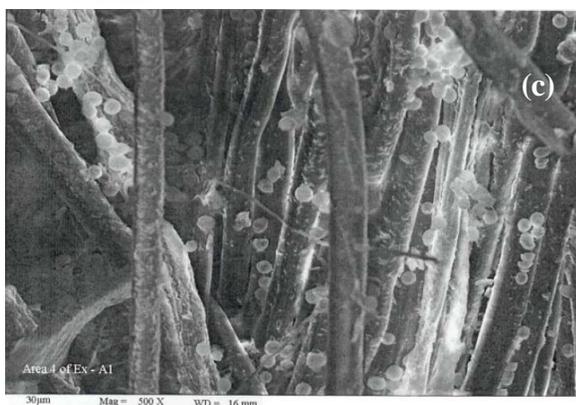
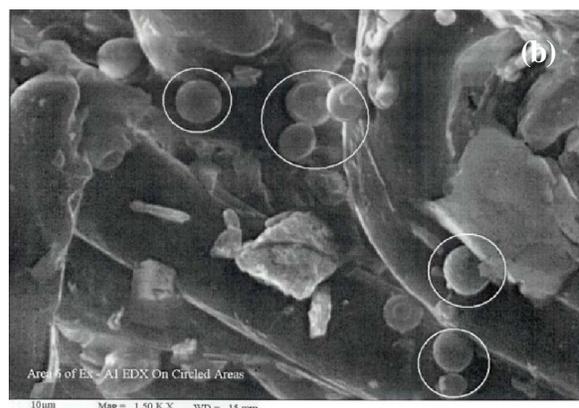


Figure 2 : (a to e) SEM of different area taken from near the suspected bullet holes

**RESULTS AND DISCUSSION**

In addition to the conventional comparison of cartridge cases and bullets of this particular case, the GSR analysis on the suspected bullet hole areas detected on the body of the garments could ascertain the presence of trace elements as could be seen from the scanning electron micrograph along with the computer generated EDX analysis. There is no evidence of trace elements in the unaffected control area of the same garment as seen from SEM shown at the Figure 1.

However, the photographs of SEM taken at the various areas near the holes present on the exhibit garment are shown in the Figures 2 (a) to (e) which clearly indicate the presence of some particles in the form of spherical globules. These globules are found on the surface of the damaged fibers of the garments having holes.

As reported in the literature, the surface morphology of GSR particles detected in the gun hand and target samples were mainly spheroidal in shape and their diameter are smaller than 10 $\mu$ m, hence the spheroidal particles found on the garments of this case are identified as GSR, which is further confirmed through EDX analysis. EDX analysis was performed on the area shown by circle mark in the Figures 2 (a) and (b). The EDX spectrum of GSR (not shown here) clearly indicates the presence of high concentration of lead and low concentration of copper and magnesium. This confirms the presence of GSR near the suspected bullet holes.

**CONCLUSION**

Ballistics examination was conducted on the small firearms / bullets / cartridge cases received in this case. Further, the examination of the garments having suspected bullet holes necessitates to go for GSR analysis to ascertain the cause of bullet hole. Our results revealed that the holes present on the garments are due to firing of bullets. The detection of GSR along with the firmly establish the firing case beyond doubt.

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