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Chemical Imaging Applied in Forensic Science using the Phenom Perception GSR

This report was extracted from Thermo Scientific literature.

Keywords: Chemical Imaging, SEM/EDS, GSR, Surface Chemical, Elemental Analysis.

Surface chemical analysis is an important tool in forensics science, specially, in cases where it is necessary to identify the elemental composition, such as GSR particles detection, mechanical evidences, traffic accidents, biological samples and etc.

Some techniques are used to analyze elemental composition, e.g. atomic absorption spectrometry or optical emission spectrometry, but these techniques only provide chemical information. The Scanning Electron Microscopy coupled to Energy Dispersive X-ray microanalysis (SEM/EDS) is able to provide the chemical composition and morphological information, being capable to analyze different kinds of samples. Therefore, SEM/EDS is an important tool to elucidate a criminal investigation through the comprehension of the chemical composition and structures of samples.

Phenom Perception GSR desktop, by Thermo Fisher Scientific, is a completely automated specific solution to forensics science. This microscope was designed to attend the forensics applications, combining SEM and EDS techniques, which permits it to be used for many forensics applications.

Among the several analysis that Phenom can perform, it is important highlight the imaging with chemical analysis.

Gunshot Residue (GSR) detection

Several crimes like, violence, murder and assassination are related with the used of firearm. In this way, determine if the firearm was used is an important evidence of the investigation process, permitting to specialist to answer questions, such as[1]:

- What was the death motivation? Was it murder, self-defense, suicide or accident?
- It brings information about how the crime took place.
- It is possible to estimate the direction, range of firing and the number of firearms that were present in this crime.
- Gives details about the firearm injury.

Therefore, the gunshot residue (GSR) detection has an important role in the criminal investigation. The analysis consists in the identification of the specific particles formed during the shot of firearm. These particles formed have specific characteristics being consisting of lead, barium, antimony and were deposited around the body of the shooter, such as, hands, face, hair and clothes. The detection of significant quantity of particles could indicate if the suspect was responsible for the shots or was very close to the shooter. Thus, the elemental analysis is the crucial method to determine if the particle has the characteristics or is consistent with GSR specimen.

Phenom Perception GSR[2] was develop combining the scanning electron microscopy (SEM) and the energy dispersive X-ray spectroscopy (EDS)[3] technique. This technology is parametrized according to international standards related to GSR identification, such as, ASTM and ENFSI, allowing the detection process automated.

The identification process starts with particles search that have GSR characteristics, e. g., size, morphology and brightness. The backscattered electron detector (BSD) recognizes potential particles from brightness intensity generated by the presence of heavy elements in the sample. Figure 1 shows the image of a potential GSR particle founded by SEM using BDS.

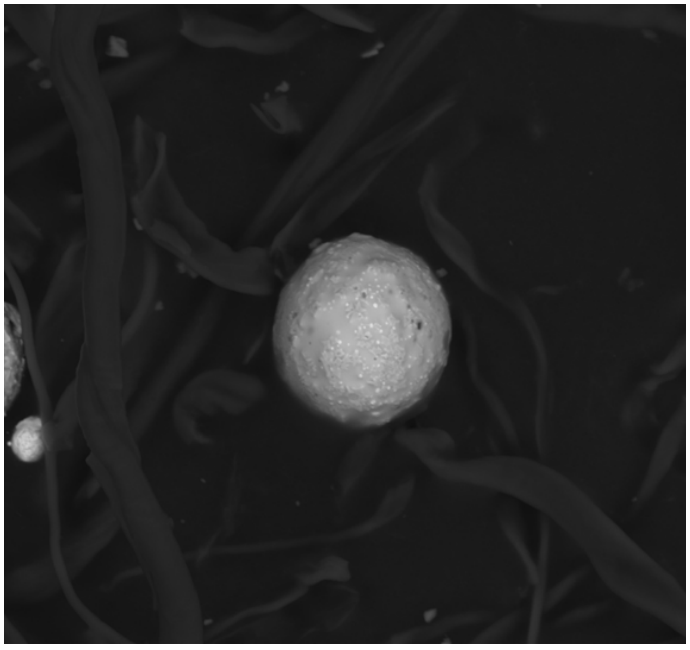

Figure 1. Image of potential GSR particle identified by backscattered electron detector (BSD) intergraded at SEM *Phenom Perception GSR*.

After finding the particle, *Phenom* uses EDS to analyze chemical composition to confirm if the specimen is in fact a GSR particle. Figure 2 shows the screenshot by software *Perception* which present GSR particle with EDS spectrum (specific signals of each elements) and the elemental percentage.

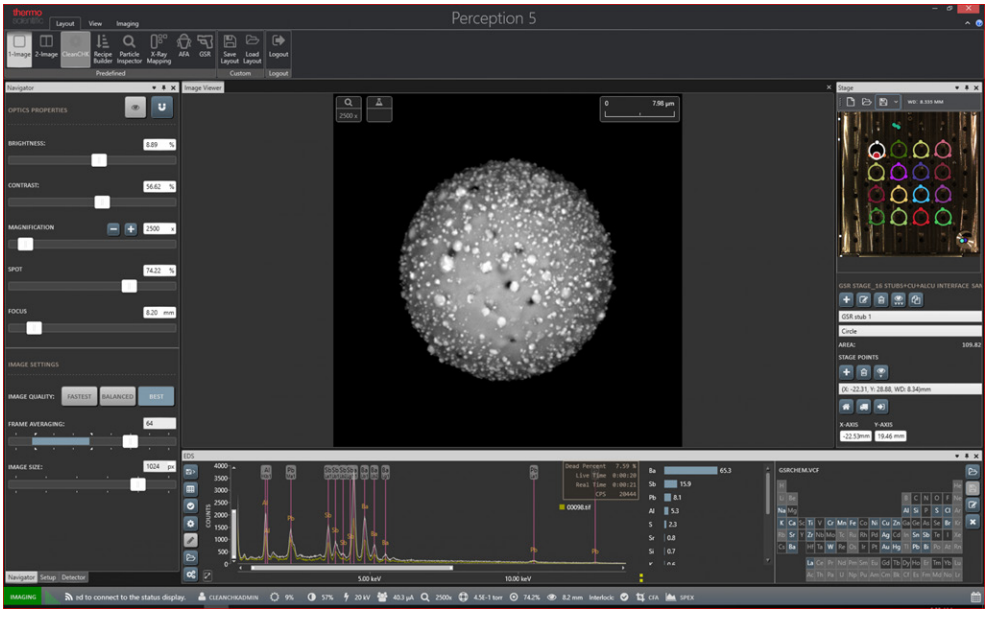

Figure 2. Screenshot of *Perception* software that shows a typical GSR particle with morphological and chemical characteristics.

An automated system provides to perform until 30 samples per analysis with a complete report contain all information about them. In this way, *Phenom Perception GSR* is an important solution in forensics science.

Traffic accidents

Scanning electron microscopy technique is an important tool applied to traffic incidents which permits forensics investigator to elucidate what has happened in the occurrence. *Phenom Perception GSR* has *ProSuite* software that permit it to perform the elemental analysis of light bulb filament providing important information, such as, indicates if the light systems (headlight, rear light or indicator) were switched on or turned off in the accident moment. In this case, it is possible to verify the presence, or not, of melted glass on the filament. Figure 3 shows the image of tungsten filament (A) and elemental analysis (B) performed in the sample originated of traffic accident. In this analysis, it is possible to identify the presence of molten glass droplet (SiO_2) on filament surface (image) and the chemical composition (elemental analysis) of a specific area using *Elemental Mapping* software, which permits to distinguish the tungsten filament from the glass droplet immediately.

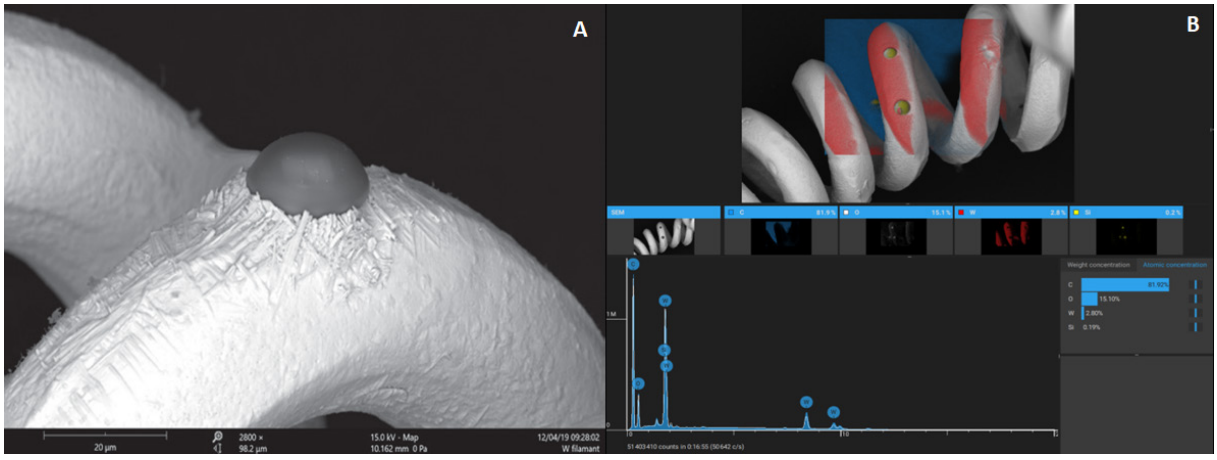

Figure 3. Image (A) and elemental analysis (B) performed on the filament with a molten glass droplet. EDS spectrum shows specific signals indicate the presence of glass (SiO_2) on tungsten filament surface.

Cases of hit and run accidents might be investigated through car paint flakes analysis[4]. Car paint is formed by different layers, permitting to compare samples from the suspect and the samples found in the accident scene. That way, it is possible to find a possible match among the samples. Figure 4 shows the EDS analysis on the paint flakes. In this analysis, it is possible to verify the composition of each layer indicated by the arrows.

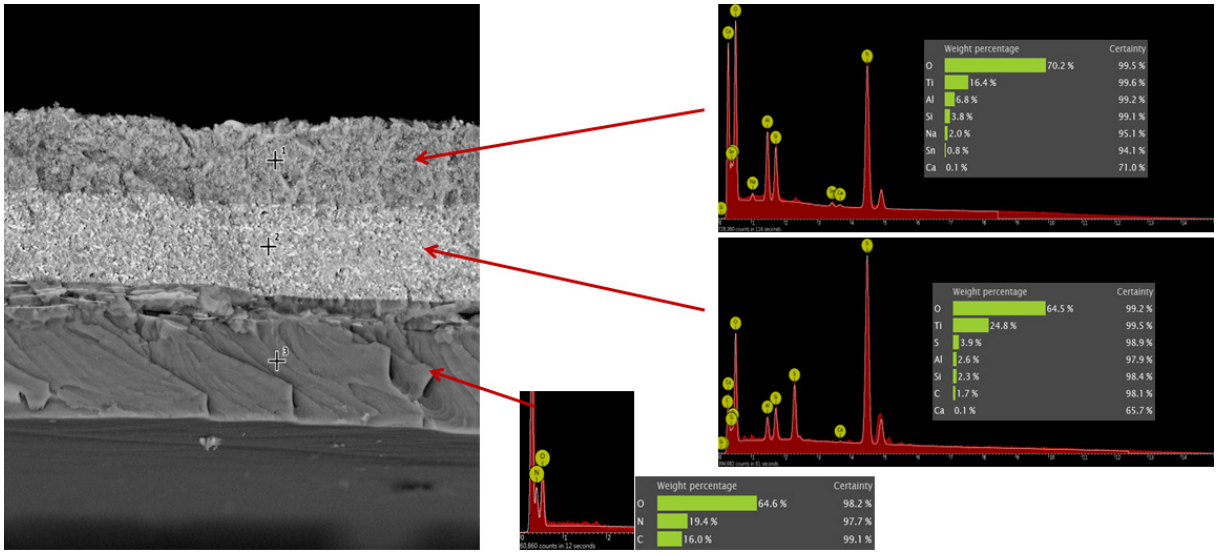

Figure 4. Investigation of car accident performed on a flake sample (Volkswagen Polo) by EDS identification.

Phenom Perception GSR Desktop SEM is the complete solution dedicated to forensics investigation. With totally automated system and fast to identify GSR particles, Perception GSR provide a complete report including morphological information and chemical composition, permitting to the forensic specialists to ensure if the suspect has used the firearm. In addition, it is possible to analyze different kinds of samples, such as, filaments, paint flakes, mechanical evidences, mineral investigation and biological samples.

The cutting-edge technologies used by Phenom Desktop SEM offer to the users the best scanning microscopy electron solution.

REFERENCES

(1) Shrivastava, P.; Jain, V. K; Nagpal, S. Gunshot residue detection technologies – a review. Egyptian *Journal of Forensic Sciences* **2021**, *11* (11). https://doi.org/10.1186/s41935-021-00223-9

(2) Phenom Perception GSR Desktop SEM, Thermo Fisher Scientific, Find out more at: thermofisher.com/phenom-gsr

(3) EDS for desktopo SEM, Thermo Fisher Scientific, Find out more at: thermofisher.com/phenom

(4) Sponsor Report, Forensics applications with Phenom desktop SEM, *Braz. J. Anal. Chem*. **2018**, *5* (21), 48-56.

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