Come out with your hands where I can see them, I have an electron beam, and I will use it.

Knut-Endre Sjåstad[1,2]

[1]*National Criminal Investigation Service, Brynsalleen 6, 0667 Oslo,*
[2] *Dept. of Geosciences, University in Oslo, Sem Sælands vei 1, 0371 Oslo, Norway*

Corresponding author: knutesj@geu.uio.no

Solving crime by use of science is an intriguing activity for the broader audience. It is easy to be impressed by watching series on TV where the "investigator" acts as a police officer collecting evidence and analysing them (often in a darkened laboratory with blue light and glass walls). And even more impressive, they achieve conclusive results within a five-minute time frame. Searching, recover, prepare, analyse, interpret and report their findings within five minutes!

Fortunately (and sometimes unfortunately), forensic science, science applied to criminal law and civil law, is a less glamorous and more painstaking process than displayed at the TV-screen. Forensic science is a wide-spread discipline that includes medicine, phycology, chemistry, biology, geology and computer science to mention some professions. One cannot expect the practitioners to be an in-depth expert in too many fields. Additionally, sub-disciplines such as forensic chemistry is divided into fields like micro-traces, investigation of shooting accidents, environmental chemistry, explosives, analysis of drugs to mention some.
Another challenge for those specialised within even one field, like micro-traces (minute traces of fibres, paint, glass, soil), is the variety of samples. Just think of the number of different paints and lacquers available. To be able to say something reasonable of these different products, the scientist needs a set of generic tools to perform relevant analysis. One of these tools are microscopy and electron microscopy. Scanning electron microscope (SEM) and elemental analysis by energy dispersive spectroscopy (EDS) has a special position in the forensic framework. The reason is all *in one* capability, extending the potential of the light microscope for visualisation and introduce indirect methods of elemental analysis by both EDS and micro X-ray fluorescence. The forensic scientist can observe a representation of the sample's morphology, topology and microstructure in addition to determination of chemical characteristics.

One of the first applications in the field of forensic science and the use of SEM was presented in 1970 [1] where investigation of ammunition was in focus. Later, the development has rocketed, and now the scanning electron microscope is one of the standard equipment in the forensic laboratory. SEM-EDS is the *gold standard* used for detection of GSRs. A seminal paper was written by the Swedish researchers J Andrasko and A. C. Maehly in 1977 where detection of gunshot residues was reported[2].

Another example is the use of SEM/EDS in analysis of micro-traces such as paint and glass. One early paper from 1972 (soon 50 years ago!) indicate the value of SEM/EDS as a suitable method for investigation of paint.[3]

Applications of SEM/EDS to perform evaluation of evidence in a Bayesian framework have uncovered more the potential for classification of glass by different statistical learning-

[1] Korda, E. J., H. L. MacDonell, and J. P. Williams. "Forensic Applications of the Scanning Electron Microscope." *The Journal of Criminal Law, Criminology, and Police Science* 61, no. 3 (1970): 453-58.
[2] Maehly, AC, Andrasko, J, *Journal of Forensic Sciences*, Vol., No., 1977
[3] Judd, G, MacQueen, HR, Ferriss, S, Journal *of Forensic Sciences*, Vol., No., 1972

methods[4].

The latest development within forensics is the use of SEM/EDS on electronic devices such as mobile phone and computers. To examine microelectronics, the SEM will provide images of electrical circuits in the region of nanometres. Also, by applying voltage to functioning circuits, it is possible to detect charging and hence obtain information of signals and data.
In this presentation, application of the scanning electron microscope used in forensics will be given from the perspective of the practitioner. Examples from real cases may occur….
In addition, the usage of scanning electron microscope will be seen in the light of other microscopic techniques so the audience will have a sneak peek into the forensic laboratory.

[4] Zadora, G. (2007), Glass analysis for forensic purposes—a comparison of classification methods. J. Chemometrics, 21: 174-186.