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New Possibilities of Complex Analysis of Explosives and Post Blast Residues in Forensic Practice

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Analysis of explosives, post blast residues is a relatively frequent task in forensic labs. It is usually easier to analyse a sample before an explosion because it is a relatively pure phase or a mixture of a few phases. However, the spectrum of possible substances combination is very wide and often even relatively exotic experiments can be encountered. At the post-blast scene, the whole mixture of substances and contaminants is created and it can be rather difficult to prove the explosive relicts in the composite sample as they can lie deep under the detection limit of a particular method.

In practice, nowadays, still new and new non-standard and homemade explosives appear and they always represent a certain risk because of their, literally, unlimited variability both in composition and construction of explosive objects. There really is an inexhaustible amount of different combinations and to get very precise and functional instruction how to construct an explosive device is not a problem. Even some experimenters, whose objective is not a terrorist attack but the desire to try out something new, get down to preparation of the many substances. However, we cannot underestimate the potential misuse of these materials for terrorist activities. Even if the legislation measures limited distribution of some explosives precursors as for example concentrated hydrogen dioxide, chlorates, perchlorates etc. in most countries, in reality, these restrictions can be bypassed e.g. by establishing a company or by elaboration of pyrotechnic compounds from fireworks containing perchlorates, etc.

Home made explosives, in the forensic practice, characterized by all available methods. The XRD techniques are widely used to great satisfaction, the used techniques are able to carry out direct phase analysis of both inorganic and organic substances in compounds. The only condition is that the substances are of a crystallographic structure. [1]

Post blast residues analysis often means a search for individual characteristic particles in a heavily contaminated material of the post blast scene. It is the microscopic thermogenetic particles (usuall 3 - 100 μm large) which are the information carriers. These are mixed with a significant excess of material affected by the explosion. The amount of the particles is often, concerning the overall compound analysis, deeply under the detection limit of even supersensitive analytical systems. That is why techniques enabling analysis at the level of individual particles are so important. The techniques used are the SEM-EDS/WDS electron microscopy ones. In some cases the information obtained by a surface analysis of microparticles is insufficient. To study internal structure of particles, their morphology and detailed constitution, a system of dual electron microscopy with a focused ion beam (SEM/FIB) is used. The devices allow cutting material at the molecular level, to carry out element mapping (EDS/WDS), 3D reconstructions from image data and analyses of chemical composition. Study of internal structure, morphology and heterogeneity can be very important for a genesis identification.[2] It is for example possible to infer if the thermogenetic particles are gunshot residue (GSR) or post blast residue particles which can, in some cases, have a related composition etc. when analyzed from a surface.

To obtain further information on both inorganic and organic components, a system is used which enables not only the element (EDS/WDS) but also confocal mapping in the Raman spectrum from the cuts carried out directly in the chamber of the dual SEM/FIB systems. An independent optical microscope is built in

the SEM chamber. The system allows to preserve all SEM functions without limitations and, besides that, also image scanning within the visual spectrum (on an area of 250μm x 250μm), high-resolution Raman spectroscopy (360nm FWHM; 430nm Rayleigh) and a possibility of mapping in the range of 250μm x 250μm x 250μm using a piezo shift of the scanner. A sample moves under it thanks to a precise microshift and, as a result, it is possible to compose an image obtain through SEM – BSE detectors, SE, CL, element map obtained by the EDS/WDS system, etc., with optical imaging in visible light and a map in Raman spectra. The data can be composed into a so called data cube and individual layers or overlaps can be displayed according to the needs. Currently, there are 3 wave lengths of excitation lasers available - 488 nm DPSS diode laser with the 50 mW output, 532 nmNd-YAG laser 75 mW and 785 nm diode laser 300mW. [3] The possibility to work in a few wave length is very important concerning the possibility to limit the often-present fluorescence. Using these techniques on a single device it is possible to carry out complex analyses without contamination risks or risks of loss of microscopic particles.

To obtain complex analytical data from various improvised explosives, experimental explosions have been carried out for a few years. These were carried out to simulate real explosions as realistic as possible. All obtained instrumental data, both from real cases and experiments, including calculated parameters, are entered into a specially created database application to serve special units. [4]

References

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