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Forensic Science Scanning Electron Microscopy, and News in this Field

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Scanning electron microscopy (SEM) can be labelled as an analytical method in the field of forensic science. It has developed into one of basic screenings that is employed for primary information about unknown samples and materials [1-2]. Majority of casework in forensic science deals with determination, description and comparisons of practically any phases, which can come into contact with persons or objects. Generally, both materials of natural origin and any materials produced by human activities can be encountered (meant in wide available interpretation).
In practise, any items can be delivered to a forensic lab (ranging from a fragment of ancient vessels, data records, documents, to materials for high tech semiconductors) [3]. Therefore, world's forensic facilities are equipped with state of the art analytical instruments, which enable to analyse a bigger part of conceivable (adjustable) materials. In this context, potentialities of SEM are of crucial importance, usually supplemented with other analytical equipment – EDS/WDS, EBSD, CL, XRF, etc. We can obtain enough information about materials examined from these sets of instruments that are necessary for decisions to perform analytical procedure, or to complete examination directly. The most important is the fact that methods are practically non-destructive and after analyses performed is evidential value fully preserved. These days even analyses of traces of considerable measurements do not pose a problem, big chambers have become a common standard and special chambers could be employed where appropriate, it is possible to examine also objects of meter size.
There has been great advancement in auto-emission electron microscopy allowing better differentiation, which is used not only in examination of nanoparticles and nanocomposites. Examinations of so-called crossing strokes in forensic field present a special application of this method (superposition of layers toner/writing tool to determine time sequence), to determine contact relict filaments (under current load) car lamps in road accidents.
Transmission detectors (TE) for standard SEM are becoming increasingly significant for morphological studies not only in nano fields. STEM mode allows employ scanning electron microscopy to yield some possibilities of transmission electron microscope.
The use of cathodoluminescence (CL) has emerged recently for technical examination of writing tools, non-homogeneous materials, growth zones of precious stones and other mineralogical objects, etc.
Focused ion beam (FIB) technology has recently left the labs and is gradually being employed in common analytical facilities. Combined systems SEM/FIB in forensic science allow by means of milling to remove material, study of inner structure of gunshot residues and post-blast residues (GSR, PBR), nanocomposites (e.g. colour variable pigments - effect paints, protecting elements, etc.). To give unambiguous conclusion for cuts of crossing strokes (which is impossible to identify using other methods, including autoemission), etc. Last but not the least there is also a wide range of possibilities embracing separate imaging of ions, which are in many cases crucial for material fields (discrimination of grain boundaries, etc.).

Special applications are increasingly occurring that enable model creation and accurate measurement in 3-D space – material studies, reconstruction of fragmented parts, ballistics, toolmark examination, defectoscopy.

Current routine use of electron microscopy (± microanalysis) is applied in casework as follows:

- unknown samples (including extortionate letters, etc.)
- mineralogical, petrologic and gemmological objects (relics of minerals, soils, precious stones and their imitations, etc.)
- gunshot residues (GSR) and shooting distance [4],
- explosives and propellants
- post-blast residues (PBR) and other thermogenetic particles
- fillers and additives of paper and plastics
- pigments and paint systems, including colour layers of art works
- cosmetic and pharmaceutical products (surface and coating layers of tablets, granular composition, phases analysis)
- morphological structure of textile materials
- determination of sorts of damage to fibres (smelting, fibre fracture, tear/cut, fracture, etc.)
- expert examinations of biological materials – trichological material and its damage, shells of original microorganisms for pedological examinations , insect eggs for post-mortal interval, etc.
- crossing strokes (superposition writing tool/print toner)
- glass
- building materials
- fracture of materials (determination of the character of fracture area)
- tool mark slipped impressions (forensic technical examinations, ballistics, unlike classical optical microscopy allows more detailed comparisons)

References

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