Society of Electron Microscope Technology

(Http://www.semt.org.uk)

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SEMT HALF- DAY MEETING

DIAGNOSTIC E.M. : Investigations in Material & Life Sciences

Wednesday 12th December 2001
at
The School of Pharmacy, 29-39 Brunswick Square, London WC1N 1AX

12.30 p.m. Registration, Buffet Lunch.

2.00 p.m. Introduction - The Chairman.

2.05 p.m. Physiochemical characterisation of airborne particulate matter:
Factors for assessing biological activity.
Kelly BeruBe *(School of Biosciences, Cardiff University.)*

2.40 p.m. Diagnostic E. M. : Past, Present and Future.
Bart Wagner *(Histopathology dept, Northern General Hospital, Sheffield)*

3.15 p.m. Tea, Coffee.

3.45 p.m. Forensic Applications of Electron Microscopy.
Alison Crossley *(AEA Technology, Advanced Materials Centre, Oxford)*

4.20 p.m. Bones and Microanalysis : A Cracking Mix !
John Cassella *(School of Environmental & Applied Sciences, Derby University)*

4.55 p.m. Sherry & Mince Pies, followed by the....

ANNUAL GENERAL MEETING

S E M T 12 December 2001

DIAGNOSTIC E.M. - Investigations in Material & Life Sciences

Physiochemical characteristics of airborne particulate matter

Kelly BeruBé
School of Biosciences, Cardiff University

There have been smogs sinbce at least the seventeenth century. Those of the 1950s were caused by poor-quality nutty slack. In december 1952, 5000 people died in 4 days; filtration gave a layer 1" thick on the filter in one hour, the particles being 5 - 300 nm. The Clean Air Act was passed in 1956; in 1952 the "excess deaths" from air pollution numbered 4,700; by 1991 this ahd fallen to 200. However, the death rate from asthma is still rising, because of PM 10 particles.

The polluting particles can come from smelter (less than 2.5 μm); diesel (much smaller); gypsum ($CaSO_4$); pollen; spores - in the Cardiff area. Urban and suburban pollution contains a lot of soot; rural contains salt (near the sea) and dust. The official Government limits on PM 10s in air is 50 $\mu g/m^3$ air, but asthma symptoms are brought on from 30 $\mu g/m^3$, and asthma deaths from 200 $\mu g/m^3$ - but these figures are from the particle mass on a filter; the majority of the weight comes from a small number of larger particles.

Particle Biological Activity depends on:

- size and shape	for penetration
- surface	absorption
- mass/number	overload
- surface chemistry	reactivity
- durability	solubility, clearance

Their studies are done with SEM, TEM, image analysis, XRMA, etc.

The flow-meter is set at 30 l/min, with a PM 10-selective-inlet filter head, and a polycarbonate filter DEP for 0.67 μm. Diesel particles come from tractors. Carbon black 50 nm; DEP 30 nm; Cabosil 7 nm; quartz 400 nm. 10 μm particles get into the thorax only; 2.5 μm particles go down to the alveoi, where the response is epithelial cell damage, inflammation, hyperplasia to fibrogenesis (deposition of collagen). Small particles with reactive cell chemistry produce damage; DEP and Cabosil produce inflammation, which can be lethal. Quartz produces metaplasia, and inflammation etc. Diesel particles are found especially in the bronchioles and alveolar system septa. Lymph nodes may contain quartz, and the less reactive DEP and carbon black. The low reactivity of carbonaceous DEP is because of aggregation. The surface chemistry is more important than size alone.

Diagnostic EM: Past, Present and Future

Bart Wagner
Northern General Hospital, Sheffield

The first use of negative staining for viruses was published by Brenner & Horne in 1959, in Biochim Biophys Acta, on Orff. Ghadially published the first textbook of diagnostic EM in 1975. Diagnostic EM was used for liver conditions in 1965; in the 1970s and 1980s often for the diagnosis of tumours.

But light microscopy looks at larger areas; few are now doing EM on tumours, exceptions being the Royal Marsden Hospital, and the Christie Hospital in Manchester. Renal work has been the mainstay of EM since the 1950s. The 1980s were the Golden Age of diagnostic EM, and accounted for all the diagnostic virology at this time, and was performed on all renal and muscle biopsies. High-quality EM textbooks were produced.

In the future, more EM localisation is expected:
- muscles, eg mitochondrial pathology eg "parking-lot inclusions"
- newly-described diseases
- digital image analysis eg variable diameters (in muscle fibres)
- EM pathology data-base - via the Web, but pictures obtained thus are not very good; ? link to human genome project
- rationalisation of EM facilities
- remote diagnosis - JA Schroeder 2001 Ultrastr Pathol 25, 301-307.

Forensic Applications of EM

Alison Crossley
AEA Technology, Advanced Materials Centre, Oxford

The labs deal with materials specimens - gunshot residues, glass analysis, paint analysis, pottery, geo-forensics, trace analysis; the results may have to be presented in court, and there may be contamination issues.
Forensic Alliance Ltd consists of:
Forensic Access - Pam Hamer, Roger Robson
AEA Technology - John Fairchild, Frank Cullen
Cellmark Diagnostics

In 1953 chemical analysis was worthless to prove the identity of glass, but this is no longer so.

The outside of the bags must be wiped as they go into the lab, to avoid contamination. The specimen may then be examined visually, by light microscopy, EM, "chemically", infra-red, etc.

Gun-shot residues would be analysed for Ba, Sb, Pb; it may be possible to associate the suspect with recent discharges. Sellotape is used to collect particles; there are automatic programs to analyse them (this is sub-contracted).

Most crimes involve broken glass -eg car, and burglary - which sticks to clothes for some time, especially polar fleece. The refractive index is determind by light microscopy, corroborated by chemical analysis. Impurities in glass include Si, Al, Fe, Ti, Ca, Mg, K, Na, Pb, Sn; these can be identified using SEM with EDX or WDX. EDX gives rapid identification of the major elements; WDX increases the sensitivity for trace elements and overlaps. Quantitative measurements require flat sample surfaces. The spectrometers must be calibrated before and after analysis, using NIST standards. and the calibrations must also be produced in court.

There are well-defined phrases for use in court: extremely strong linkage, / very strong / some scientific evidence.

Laminated glass may have different compositions in the different layers.

Paint is transferred in hit-&-run cases; she would like to have a data-base from the manufacturers of the cars.

BSE analysis of pottery glaze needs to be done by experts.

Geoscience deals with pollen, spores, diatoms in sedimentology, and soil characteristics. Diatoms, silicaceous, may have species specific to an ecological environment.

In the Enniskillen bombing, FTIR showed that a piece of blue plastic came from a 6V handlamp battery; a circuit-board fragment from a home-made timer.

Not all of the trace evidence is necessarily applicable - more than half of all £5 notes are contaminated with cocaine !

It may be possible to tell what environment the specimen had been in, eg a fibre had been in a lab with KBr substrate.

The evidence should be maintained unchanged for further analysis if necessary.
- environmental SEM
- low voltage SEM
- micro-focussed XRF (replacing EDX/WDX)
- laser ablation mass spectrometry

SPM could expand the horizons further.
DNA analysis should be backed up with other analyses.

Bones and Microanalysis: A Cracking Mix !

John Paul Cassella
School of Environmental & Applied Sciences, Derby University

They are hunting for changes in the collagen and mineral in bone. Osteogenesis Imperfecta is caused by a Type 1 collagen mutation, not genetic like osteoporosis. OI is known from Egyptian mummies. It can be wrongly diagnosed as child abuse, from multiple fractures, and bowing of the bones. The eyes have blue sclera. In bad cases a "shish-kebab" operation can be done - the bone broken in as many places as necessary, and re-assembled on a pin.
Brittle Bone Society.

There are changes in the mineral deposition, and subtle variations in the diameter of the collagen fibres, which become bigger because of kinks.

XRMA - inexperienced users may not understand the principles, and mis-interpret the results. Much of the working is now automated, and thus out of the operator's hands.

Hydroxyapatite is not the only calcium phosphate in bone.
There is a transgenic mouse whose ribs fracture easily, just with respiration, as do the limbs.

There is treatment with biphosphonates, but this makes big changes in the calcium phosphate, and we don't really understand what is happening.

Brachiopods - Lingula - have calcium phosphate shell.

Cassella et al 1995

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