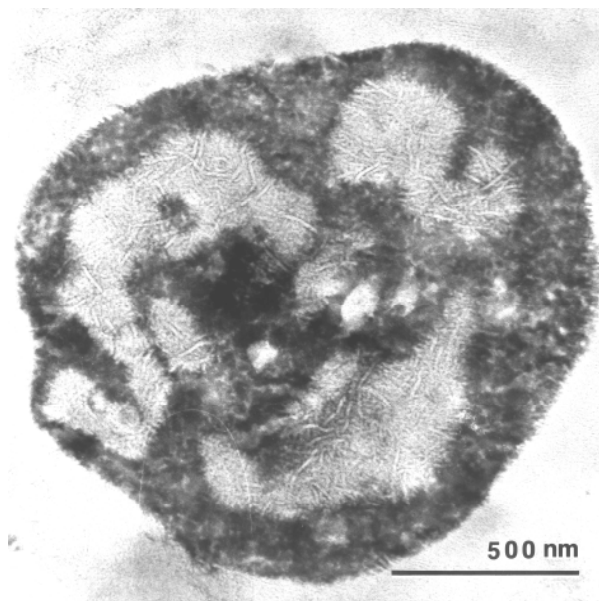


## ***Electron Microscopy***

A microscope is a device for revealing structures too small to be seen with the famous "naked eye". A conventional light microscope can resolve features as small as a quarter of a micron: a limit dictated by the light's wavelength. An electron microscope exploits the much smaller wavelength associated with an accelerated electron beam to resolve features down to the atomic scale.

### **Transmission Electron Microscopy**

Analogous in function to a light microscope, this instrument uses magnetic lenses to focus a magnified image onto a phosphorescent screen or a digital camera. Typically, the TEM yields information on the internal structure of materials, and its use commonly necessitates the preparation of a sample film or section no thicker than 60-80 nanometres, through which the electron beam is transmitted. Sample preparation may involve not only the skilled art of ultra-microtomy, but also embrittlement by cooling or chemical fixation, and staining to impart contrast to the image.



### **Rubber-toughened Polypropylene**

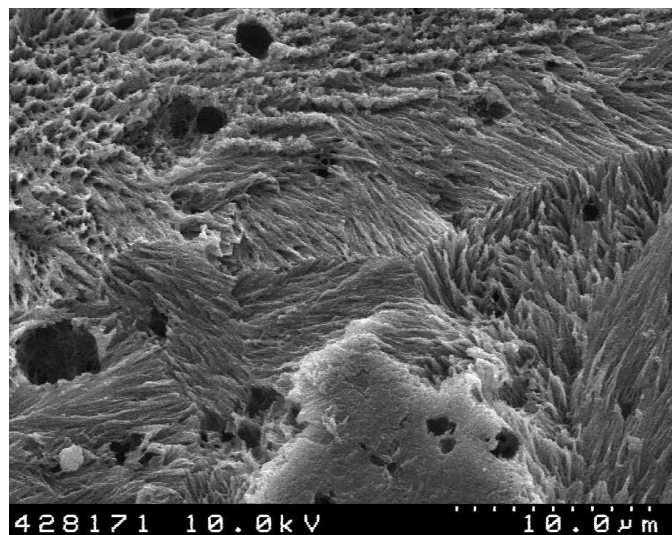
The thin-section illustrated above was cut from a block of polymer pre-treated with ruthenium tetroxide.

In addition to imparting contrast by selectively staining amorphous polymer, the ruthenium hardens the material sufficiently to permit room-temperature

sectioning. TEM embraces a range of techniques that combine to provide morphological, compositional and crystallographic information.

### **Scanning Electron Microscopy**

The technology of electron-probe micro-analysis led to the development of the SEM, an instrument that images surfaces at a broad range of magnifications. A focussed electron beam is swept across a precisely-controlled area of the specimen's surface, while a detector captures the emerging secondary electrons and generates an emission map on a CRT: the resulting image offers excellent "depth" at low magnifications, and a resolution of 1.5 nanometres at the high end. A field-emission electron source renders MSG's Hitachi S4500 instrument particularly suitable for examining sensitive materials such as polymer lattices and biological tissues.



### **Permanganate-etched PEEK**

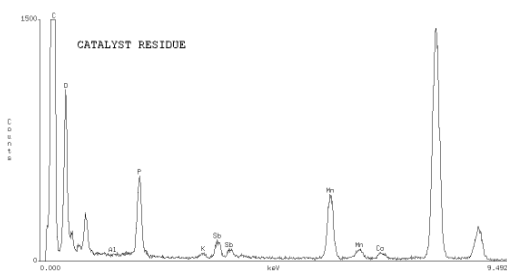
This polymer has been embedded, polished and exposed to a chemical etch in order to reveal the crystalline structure: the surface has been coated with a very fine layer of platinum to render it conductive to the electrical charge imparted by the electron beam.

### **More than pictures**

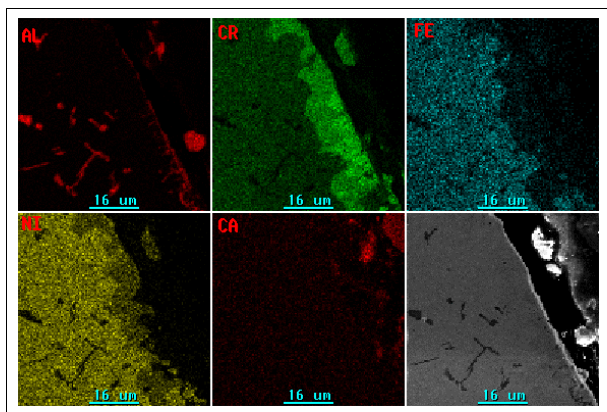
Scientists love micrographs for the same reasons most people love the visual arts: for the high density of unique information and immediate impact of a picture; the "thousand words" thing. But for electron

microscopists, the picture is often just the beginning of the story. As with a light microscope, the back focal plane of a TEM's objective lens carries a diffraction pattern of the specimen, and a simple change in lens configuration (equivalent to the use of a Bertrand lens in LM) allows us to image this pattern and identify crystalline components of the specimen.

Advantages specific to electron microscopes include the x-rays which are produced by fluorescence when an electron beam of sufficient energy strikes a specimen. Such x-rays are most commonly processed according to their energies: this energy-dispersive x-ray analysis typically results in a histogram containing families of peaks which are characteristic of the elements present in the interaction zone of the beam with the specimen. In the TEM, this region may be very small: we are therefore able to analyse tiny particles with considerable accuracy.



This x-ray spectrum was collected from a particle of catalyst residue around 30 nanometres in size within a thin-section of polymer.



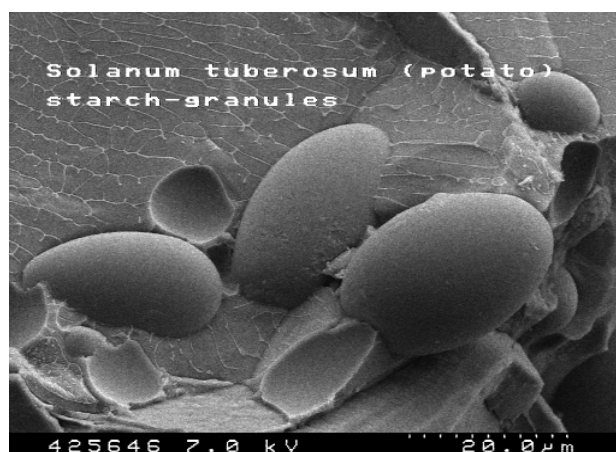
In an SEM (or a TEM operating in a scanning mode), peaks from such a spectrum can be selected and used to generate a series of element maps alongside a conventional image. The maps shown illustrate a

corroded steel component, embedded in resin and polished in cross-section. Evidence of metal relocation, depletion and oxidation is seen. Point analyses within selected regions can yield quantitative data to support the visual evidence.

Other means of generating compositional and quantitative data available to us include electron energy-loss spectroscopy and on-line image analysis for volume fraction, particle size, aspect ratio, etc.

### Recent Developments

Electron microscopy traditionally involves exposing the specimen to a high vacuum. Water and other liquids must either be removed or replaced with a suitable embedding medium: artefacts invariably result. A recently-acquired cryo-attachment on our high-resolution SEM allows us to carry out specimen preparation and microscopy at temperatures as low as -180°C. The image below shows starch granules (amyloplasts) in frozen cytoplasm within fully hydrated potato tissue.



With new investment, Intertek MSG can now offer WetSTEM via its new Environmental SEM. See separate flyer for more detail.

To learn more about electron microscopy, contact any member of the EM team. We are:  
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