CNH Centre for NanoHealth

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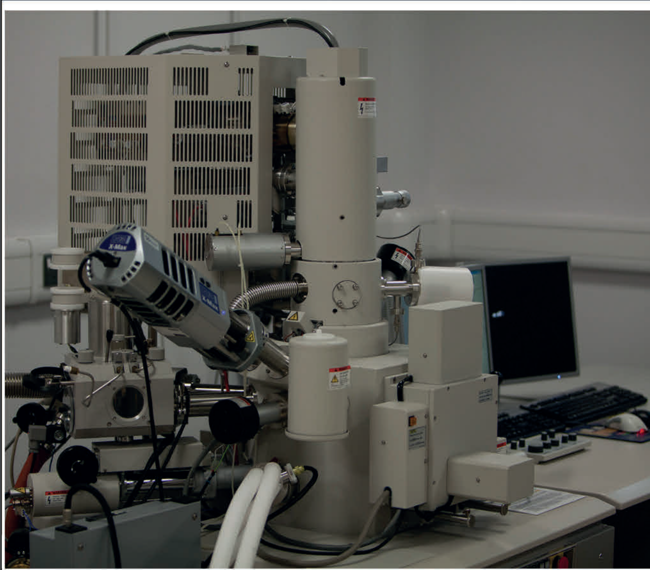
Scanning Electron Microscope



The Hitachi S4800 Scanning Electron Microscope uses an electron beam to image the surface of solid materials. This requires a vacuum chamber to form and control the beam, similar to an electric current in a wire but passing through free space. The SEM uses electromagnetic lenses to focus the beam rather than glass lenses found on light microscopes. The lenses along with apertures refine and focus the beam so that features smaller than 5nm can be imaged. The microscope also has the capability of cryogenic sample preparation and imaging. This overcomes damage to the sample that can be caused by exposure to vacuum.

Specifications

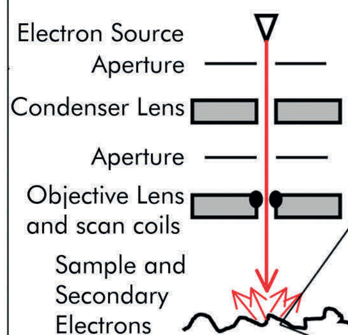
- Up to 800k × magnification
- Maximum resolution of 1.4nm @ 1kV
- Accelerating voltage 0.5-30kV
- Backscatter electron detector capable of 3nm resolution

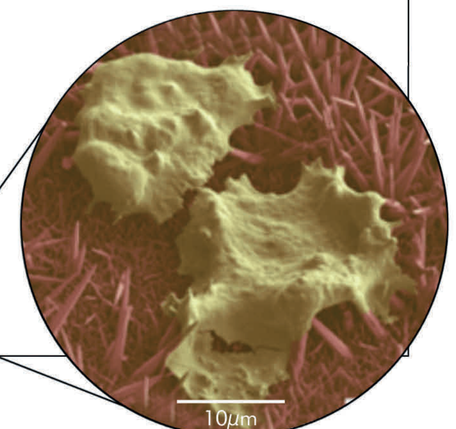
Features

- Energy Dispersive X-ray Spectroscopy (EDX) for composition mapping.
- Cryogenic capabilities for biological samples.
- Backscatter Electron Imaging.
- Low energy Scanning Transmission Electron Microscopy (STEM).
- Nanoscale imaging capabilities (1.4nm resolution).

Benefits

- Fast analysis allows multiple samples to be viewed, enabling the user to optimise process parameters quickly.
- Image extremely small features to improve understanding of a material.
- Investigate materials or product failures to enhance quality or productivity.
- Identify compositional and physical components in a material to improve a process.
- Reduce analysis time over surface techniques such as AFM and XPS.





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Case Study

Picofluidics Limited (www.picofluidics.com) is an SME based in Cardiff which designs process equipment to fabricate micro-structures for use in semiconductor and healthcare industries.
When working with Through Silicon Vias (TSVs) from an external supplier it is necessary to establish the integrity of the thin PVD Cu layers within the Via (a blind hole in a silicon wafer). One of the areas of concern lies close to the opening at the top of the via where there is some undercut due to the Si etch process steps. As the PVD process is principally a "line of sight" process – ions landing on the substrate perpendicular to the wafer surface – there is concern that insufficient numbers of Cu ions will land in the undercut area to produce a continuous coating. If the coating is not continuous it will not be possible for Picofluidics to electrochemically fill the via with Cu.
In the Scanning Electron Micrographs below – taken using the Hitachi S4800 SEM at the Centre for NanoHealth – we can see an example of a recent deep TSV structure.

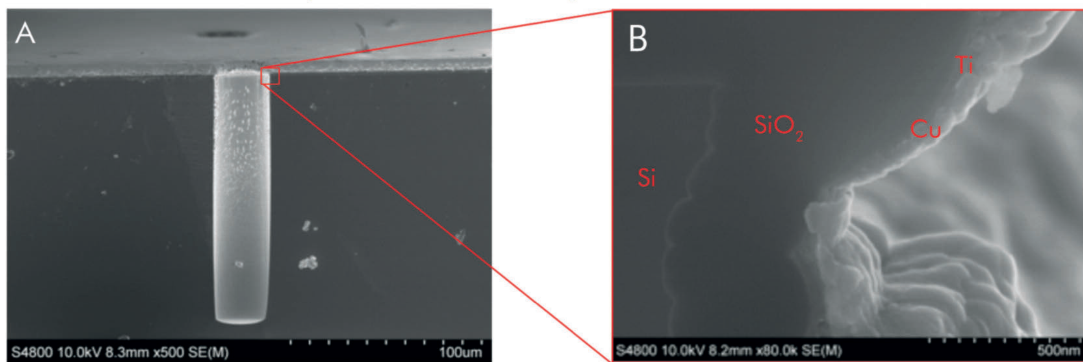
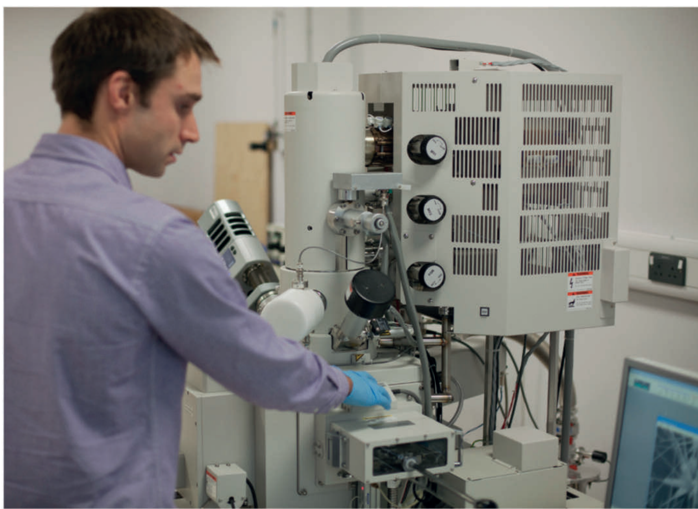


Fig 1. A) Micrograph of high aspect ratio via in Si. B) High resolution SEM micrograph of undercut at the opening of the via

In fig 1. A) we can see a single via – a feature large enough to be resolved by an optical microscope. However, in fig 1 B) we can see a higher magnification view of the corner feature. The Cu film was shown to be continuous even in the re-entrant feature near the top of the via. The Ti diffusion barrier and SiO_2 liner layer can be seen along with the etched Si substrate. The detail in Fig 1B) could not be resolved by optical microscopy.
By examining a number of vias using the SEM, we can establish with a high degree of certainty which substrates should yield good results when they receive further processing at Picofluidics and those that should not be processed.



Area of Interest	Applications
Metals / Semiconductors	• Metals processing • Semiconductor Devices • Solar power
Powders & Colloids	• Food processing • Pharmaceuticals • Paints • Cake analysis
Biological Samples	• Pharmaceutical Research • Pest control
Polymers	• Water treatment • Filtration

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