Hitachi S-4700 Field Emission Scanning Electron Microscope

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Scanning Electron Microscopy

- The Scanning Electron Microscope can yield detailed surface information, from 30x to 500,000x magnification
- Analytical software for Energy Dispersive X-Rays analyses the energy released from the material due to the impact of the electron beam. Elements as light as Boron can be detected.
- Electron Backscatter Diffraction can provide information on crystal orientation, texture, phase, grain statistics and strain conditions.

Hitachi S-4700

What Can Be Studied?

In General

- Optical Materials
- Ceramics
- Dental Materials
- Biomaterials
- Plastics
- Pharmaceuticals
- Geological Materials
- and more...

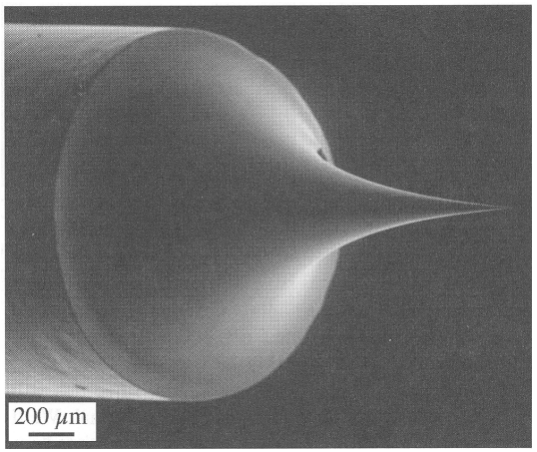
For example, our SEM has been used to study

- bacteria and cancer cells
- types of fracture surfaces for failure analysis
- phytoliths and shells
- homogeneity of alloy mixtures
- wear patterns on metallic materials
- sizing and shapes of powders
- metallic materials

Advantages of This SEM

- The cold field source gives unsurpassed resolution for *all* accelerating voltages:
  1.5 nm at 1.5 kV
  2.5 nm at 15 kV

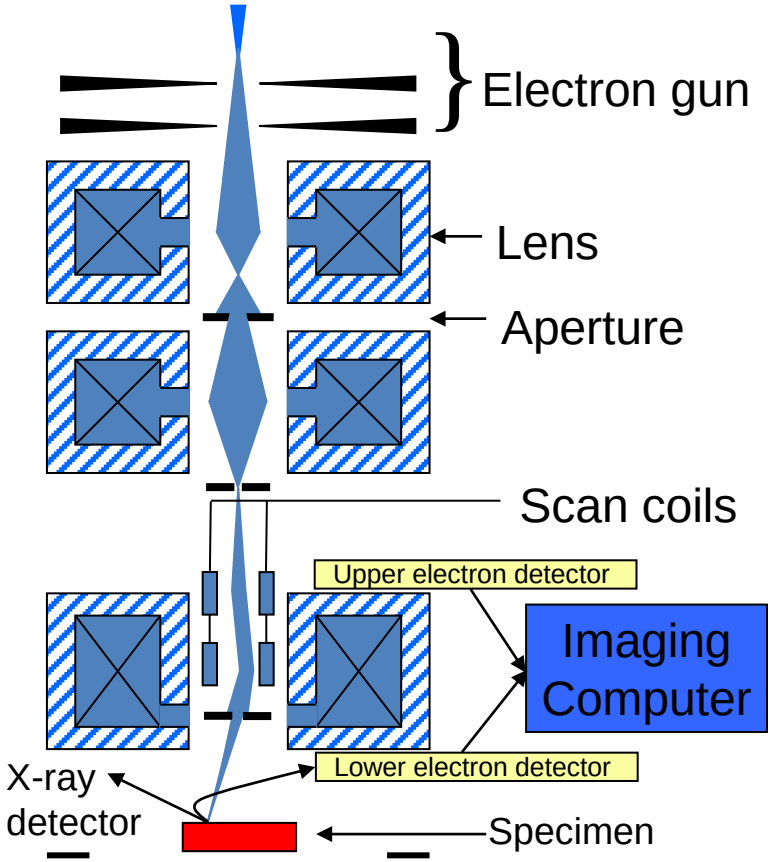
- ExB through-the-lens detector design allows the user to select the high resolution (SE) or atomic number contrast (BSE) signal for optimal imaging.



Tungsten cold field emitter

How Is An Image Obtained?

- Electrons are extracted from a sharp tungsten tip and formed into a fine beam by a series of electromagnetic lenses.
- The beam is rastered over the surface of a specimen and the signals are collected point by point to form a grayscale image.
- Secondary electrons are detected and converted to grey-scale images.



System Specifications

- Magnification from 30x to 500,000x
- Resolution: 1.5 nm at 1.5 kV
  2.5 nm at 15 kV
- EDS spectrometer sensitivity
- Backscatter detector for elemental contrast (with ExB filter)

Sample Requirements

- Materials that are prepared for the high vacuum system need to be clean and dry, and of a size that will fit into the sample chamber.

- Non-conductive materials should have a conductive layer applied. Resolution can be obtained down to 2nm when optimized.

Who Are Our Clients?

- We have assisted researchers from over 22 departments and six different universities around Atlantic Canada further their understanding of their materials. These include metallic materials, optical materials, ceramics, dental materials, biomaterials, plastics, pharmaceuticals and geological materials.

- We have also helped various industries with failure analysis and quantitative chemical analysis of their samples.

Success Stories

Collagen Studies, Dr. J. M. Lee

The Goal

To uncover the nano- and molecular-scale failure mechanisms that operate within collagenous tissues when they experience tensile overload.

Collagen is the major structural protein common to all members of the animal kingdom. Tendons, ligaments, and bones all derive their strength from collagen fibers.

Success Stories

Collagen Studies, Dr. J. M. Lee

The Result

The Lee group has been able to show that collagen fibrils—quasi-crystalline nano-scale collagen fibers—undergo a tensile failure mechanism involving repeating (Figure 1). In combination with enzyme probes ,the SEM has been used to show that tensile overload changes the conformation of the collagen molecules within the kinked regions of fibrils (Figure 2).

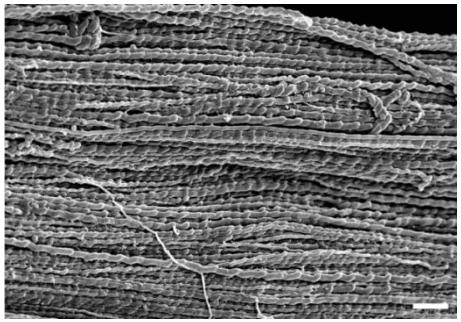


Figure 1. Tensile overload creates collagen fibrils with a regular kinking pattern. Bar 1 um.

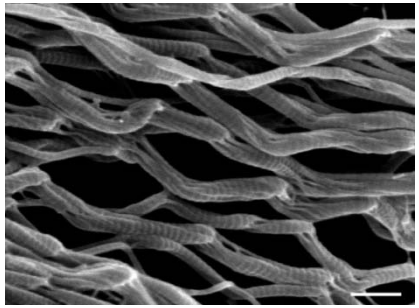


Figure 2. Selective enzyme degradation of collagen fibrils shows that molecules in the kinked regions have undergone a conformational change. Bar 300 nm.

Success Stories

AL-Si Alloys, Dr. Zoheir Farhat

The Goal

Al–Si alloys are widely used in a variety of automotive components due to their excellent strength to weight ratio. Porosity adversely affects the mechanical properties and wear resistance of these components. In the present investigation, dry sliding wear behavior was investigated against AISI 52100 bearing steel ball using a reciprocating ball-on-flat configuration for cast and sintered samples.

Success Stories

AL-Si Alloys, Dr. Zoheir Farhat

The Result

It is found that wear within the present load and frequency ranges is due to plastic deformation and delamination. Hot isostatic pressing treatment decreases the total amount of porosity and average pore size, but at the expense of reduced hardness. The competition between the beneficial effect of lower porosity and the detrimental effect of lower hardness determines the final wear rate.

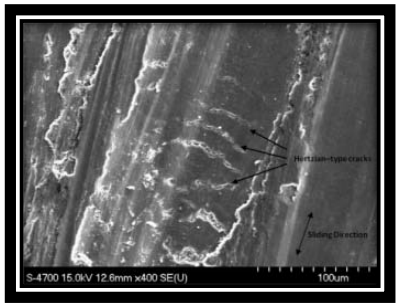
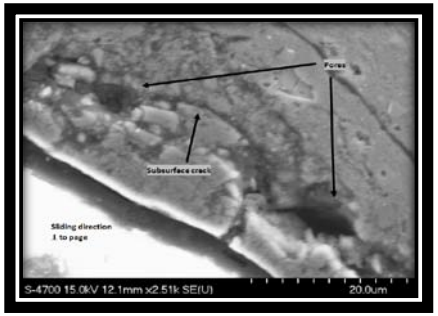


Figure shows cracks perpendicular to the sliding direction as a clear evidence of Hertzian cracks developed during the wear process.



Cracks extend and create a network of cracks by connecting different subsurface pores.

Selected Publications

- "Designed to Fail: A Novel Mode of Collagen Fibril Disruption and Its Relevance to Tissue Toughness". Samuel P. Veres and J. Michael Lee. Biophysical Journal Volume 102 June 2012 2876–2884.
- Gibbons, M.K. and G.A. Gagnon. 2011. Comparison of phosphate and arsenate adsorption onto water residual solids. J. Hazard. Materials. 186: 1916-1923.
- Mann, R. E. D., Hexemer Jr., R. L., Donaldson, I. W. and D.P. Bishop, "Hot Deformation of an Al-Cu-Mg Powder Metallurgy Alloy", in press, Engineering and Applied Science A (2010).
- MacAskill, I. A., Hexemer, R. L., Donaldson, I. W. and D.P. Bishop, "Effects of Magnesium, Tin and Nitrogen on the Sintering Response of Aluminum Powder", Journal of Materials Processing Technology, 210, 2252-2260 (2010).
- Hilchie, A.L. and Hoskin, D.W. (2010). Application of cationic antimicrobial peptides in cancer treatment: Laboratory investigations and clinical potential. In Emerging Cancer Therapy: Microbial Approaches and Biotechnological Tools. A. Fialho and A. Chakrabarty, Eds.
- Novel Method to Produce Single-Walled Carbon Nanotube Films and their Thermal and Electrical Properties. M. B. Jakubinek, M. B. Johnson, M. A. White, J. Guan and B. Simard. Journal of Nanoscience and Nanotechnology 10, 8151-8157 (2010).
- C.D. Munro and K.P. Plucknett, 'Aqueous Colloidal Processing of Multimodal BaTiO3 powders,' *J. Am. Ceram. Soc.*, **92** [11] 2537-2543 (2009).