University of Birmingham

Microscopes and ancillary equipment

Transmission Electron Microscopes

Open all sections

Jeol 1200EX with SEM and STEM unit. (LaB6 filament)

LoJeol 1200EX TEM with SEM and STEM Unit

The JEOL 1200EX is a transmission electron microscope with an operating voltage ranging from 40 to 120 keV. It is fitted with a LaB6 filament.

This TEM is mainly used by life science researchers for observation of ultra thin sections of biological tissue.

It is fitted with ASID scanning unit enabling STEM visualiation of thick unstained sections and high resolution SEM imaging.

Jeol 2100 200kV LaB6 TEM with Oxford INCA EDS

The JEM-2100 electron microscope provides solutions for a wide range of problems in the fields of materials, nanoelectronics, and biological sciences.

The JEM-2100 features a high-stability goniometer stage specifically tuned for high tilt tomographic applications.

The JEM-2100 has three independent condenser lenses and produces the highest probe current for any given probe size, which allows for improved analytical and diffraction capabilities. The patented JEOL Alpha Selector™ allows a user the selection of a variety of illumination conditions, ranging from full convergent beam to parallel illumination.

The standard incorporation of the objective mini lens means that Lorentz microscopy is a standard feature of this microscope. A high contrast aperture is available for any choice of polepiece, allowing high contrast imaging and simultaneous EDS.

The Jeol 2100 laB6 TEM is fitted with an Oxford Instruments INCA EDS system.

Philips Tecnai F20 with STEM, Gatan EELS and Oxford Isis EDS

FEI Philips TECNAI F20 with Oxford Instruments ISIS EDS, and Gatan digi PEELS. The machine has the capabilities for Diffraction, STEM imaging , a double tilt goniometer stage and Digital image collection.

Tecnai F20

The field emission gun transmission electron microscope from FEI.

- Point Resolution: 0.24nm
- Line Resolution: 0.12nm
- Cs objective: 1.2mm
- Cc objective: 1.2mm
- Focal length: 1.7mm
- Schottky Field emitter
- High tilt (40O) double goniometer
- STEM, resolution about 0.2nm
- Gatan TV Camera, Oxford ISIS EDX and Gatan digiPEELS detectors

This is a Regional Facility wth the Universities of Birmingham, Warwick and Loughborough.

Used for both Materials Sciences and Life Science work.

Scanning Electron Microscopes

CFEI Quanta 3D FEG FIB-SEM

The Quanta 3D FEG is a versatile high-resolution, low vacuum SEM/FIB for 2D and 3D material characterization and analysis.

The Quanta 3D FEG's field-emission electron source delivers clear and sharp electron imaging. Increased electron beam current enhances EDS and EBSP analysis. Featuring three imaging modes – high-vacuum, low-vacuum and ESEMTM

Quanta 3D FEG's high-current FIB enables fast material removal. Automated FIB sectioning recipes enable accurate cross-sectioning.

Electron beam resolution

- High-vacuum
  - 0.8 nm at 30 kV (STEM)*
  -1.2 nm at 30 kV (SE)
  -2.5 nm at 30 kV (BSE)*
  -2.9 nm at 1 kV (SE)
- Low-vacuum
  -1.5 nm at 30 kV (SE)
  2.5 nm at 30 kV (BSE)
  -2.9 nm at 3 kV (SE)
- Extended low-vacuum mode (ESEM)
  -1.5 nm at 30 kV (SE)

Ion beam resolution

7 nm at 30 kV at beam coincident point (5 nm achievable at optimal working distance)

Electron optics

- High-resolution field emission – SEM column optimized for highbrightness/ high-current * optional
- 60 degree objective lens geometry with through-the-lens differential pumping and heated objective apertures
- Accelerating voltage: 200 V – 30 kV (optional down to 100 V)
- Probe current: up to 200 nA -continuously adjustable
- Magnification 30 x – 1280 kx in " quad" mode

Ion optics

- High-current ion column with Ga liquid-metal ion source
- Source lifetime: 1000 hours guaranteed
- Acceleration voltage: 2 – 30 kV
- Probe current: 1 pA – 65 nA in 15 steps
- Beam blanker standard, external control possible
- 15-position aperture strip
- Magnification 40 x – 1280 kx in " quad" mode at 10 kV
- Charge neutralisation mode for milling of non-conductive samples

Chamber vacuum

- High-vacuum: < 6e-4 Pa
- Low-vacuum: 10 to 130 Pa
- ESEM-vacuum: 10 to 4000 Pa
- Pump-down time (high-vacuum): < 3 minutes

Vacuum system

- 1 x 240 l/s TMP
- 2 x PVP oil-free (scroll-pumps)
- 2 x IGP (for electron column)
- 1 x IGP (for ion column)
- Proprietary through-the-lens differential pumping
- Beam gas path length: 10 or 2 mm
- Seamless transition between high and low-vacuum
- Imaging gas in low-vacuum and ESEM: water vapor or auxiliary gas

Jeol 6060 with Oxford Inca EDS

Specifications

- Resolution HV-mode: 3.5nm@30kV
- Resolution LV-mode: 4.0nm@30kV
- LV pressure range: 1 to 270 Pa
- Acc. Voltage: 0.5 to 30 kV

- Stage movements: 10 x 20 mm

This instrument is a conventional SEM with the added capability to also work with poorer vacuum in the specimen chamber.

The vacuum level in the chamber is automatically maintained at a settable value by a separate extra pump with a large foreline trap and an unique type of vacuum orifice protecting the column and objective lens apertures.

The detector most often used in LV-mode is a patented 3 elements solid state detector which gives both topographic images and Z-contrast images.

When operated at normal high vacuum levels the performance of these SEMs is identical to the equivalent conventional model.

Important extra possibilities obtained by the LV technique are:

Study of samples with poor or no electrical conductivity which conventionally are either coated with an electrically conductive coating (which takes time and hides the true surface) or studied at low voltages (which does not give backscatter or X-ray information).
Working in LV-mode at a typical optimum pressure in the range of 20 Pa will neutralize the build-up of the negative electrostatic charge on the sample with the positive ions generated in the chamber gas. Not only can excellent topographic images be obtained but also both backscatter images with compositional Z-contrast and X-ray analysis.

Study of samples containing volatile substances (e.g. water, oils) which normally require drying by advanced and/or time consuming methods. In LV-mode such samples can often be studied directly.

This instrument is fitted with an Oxford instruments Inca 300 EDS system

Jeol 7000F with Oxford Inca EDS, Wave WDS and Crystal EBSD

Specifications

- Resolution: 1.2 nm at 15 kV, 3.0 nm at 1 kV
- Emitter Schottky TFE
- Probe current 10-12 to 2x10-7 A
- Magnification 10 - 500,000 X
- Stage 1.XY 50x70 mm
- Stage 2.XY 110x80 mm
- Stage Z 1.5 - 41 mm
- Rotation 360º eucentric
- Sample size 150 mm max. 200 mm option
- Tilt - 5º to + 60º

The combination of a unique in-lens gun with Schottky emitter with the strongly exited conical lens design, give instruments with both high resolution at all voltages and working distances and exceptional analytical capabilities. A continuously variable stable beam current of up to 200 nA makes these ideal platforms for WDS (wave dispersive X-ray spectrometer), EBSP (electron backscattering patterns) cameras, as well as for normal EDX (energy dispersive X-ray spectrometers)

In the Centre for Electron microscopy the JSM-7000F is fitted with Oxford Inca EDS, Wave WDS and Crystal EBSD.

Combined ED/WD microanalysis

Combining an EDS spectrometer and WDS spectrometer on an SEM allows the microanalyst to take advantage of the strengths of both techniques. EDS is used for fast sample investigation. If more information is needed, for example to resolve peak overlaps, the WDS spectrometer can be used to provide more detailed spectra. Data from EDS and WDS spectrometers can also be combined for the most accurate quantitative analysis, and also for X-ray mapping.

Philips XL-30 (LaB6) with Link Isis EDS

General purpose 50x50 millimeter stage SEM fitted with LaB6 filament.

This SEM is fitted with an Oxford Instruments INCA EDS system and a HKL EBSD system with NordlysS camera.

HKL CHANNEL5 uses a modular approach to its various functions and software licenses. All software modules interact seamlessly with one another and form a powerful and expressive suite with which to perform microstructural characterization. HKL CHANNEL5 is aimed at materials scientists in academic and industrial research and industrial process control. Geologists will also find it supports their research needs with low symmetry indexing, pseudosymmetry correction and large area mapping with stage control on most SEM's.

Successful and accurate data acquisition is fundamental to any EBSD analysis. Any acquisition software must be designed not only for accuracy and reliability, but also for versatility.

Therefore the HKL CHANNEL5 Flamenco allows image collection, versatile EBSD analysis (works with both NordlysS and NordlysF+) and phase identification all within a

single program.

NordlysS – Specifications

- Easily retractable when not in use
- 12-bit digital CCD camera with on-chip integration
- Pixel clock rate: 20 MHz
- Camera resolution - 1344 x 1024 pixels - 100% pixels utilized
- Pixel binning - up to 8x8 Superfast for high speed
- Speeds up to 106 EBSPs per second
- Digital enhancement and camera control in the CHANNEL5 acquisition software
- Minimal geometric distortion
- Fully motorized insertion and retraction, with remote control
- Detector positioning to within 0.1mm
- Automatic safety mechanism, with audible touch alarm and auto-retraction to prevent damage
- Rectangular phosphor screen, matching shape of CCD chip
- Tapered nose section - allows positioning closer to sample with less shadowing of other detectors
- Capture angle can be adjusted from 15°-130° without refocusing, SEM dependent
- Optional integrated forescatter detector system with built-in electrical feedthrough - can be retrofitted at a later date
- Up to 6 forescatter diodes possible, giving both orientation and phase contrast
- The detector can be moved between different SEMs
- Detector size (outside chamber): 390 mm long, 75 mm diameter

Philips XL-30 FEG Environmental SEM with Oxford Inca EDS

This instrument is fitted with a Oxford Inca 300 EDS system.

The Philips XL30 ESEM-FEG offers high resolution secondary electron imaging at pressures as high as 10 torr and sample temperatures as high as 1,500 oC. This means that wet, oily, dirty, outgassing and non-conductive samples can be examined in their natural state without significant sample modification or preparation.

The XL30 ESEM-FEG is the first Scanning Electron Microscope (ESEM®) to employ the stable, high brightness Schottky Field Emission Source for outstanding observation performance of potentially problematic samples for conventional high vacuum SEMs.

Key Benefits:

- True secondary electron imaging at 10 torr chamber pressure
- No charging of non-conductive samples
- Low-Z materials
- Observation of contaminating samples
- Porous material observation
- BC stability < 1% / hour, Schottky emitter
- Hydrated samples remain fully stable
- No coating interference
- Phase transitions
- Hydration processes
- Oxidation/corrosion
- Stress testing

The benefits of the ESEM-FEG are realized by eliminating the high vacuum requirements of SEMs in the microscope chamber. This is done by separating the vacuum environment in the chamber from the high vacuum environment in the column and FEG source area.

Two Pressure Limiting Apertures (PLAs) separate the microscope chamber from the FEG column. The three regions created by these PLAs are separately pumped. This causes a graduated vacuum from 10 torr in the chamber (above the vapor pressure of water) to 10-8 torr in the middle region of the column down to 10-10 torr in the emission chamber.

Low vacuum and conventional high vacuum modes can be selected as can the chamber pressure in Wet mode (using water vapor) and Aux mode (using any other gas.)

Additionaly the instrument has a PolarPrep 2000 cryo-stage system fitted enabling observation of rapidly frozen hydrated samples at temperatures down to -150° C

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