ENBIO CHARACTERISATION EQUIPMENT & SERVICES

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MICROSCOPY

Fluorescent Microscope with DFC420 Camera
Leica/Reichert

Leica microscope with achievable magnifications up to 1400×. No oil immersion necessary. Carl Zeiss lenses. Inspection under UV light source highlights minor defects and structures.

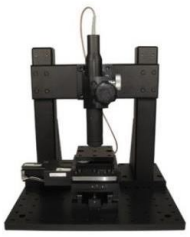
- Leica objectives feature maximum correction and optical efficiency allowing for high magnification (10–140×) without oil immersion.
- Carl Zeiss eyepieces (10×).
- Halogen and UV light sources with bright and dark field capability.
- Image capture capability (Leica DFC420 camera).

Stereo Inspection Microscopes
Brunel

This microscope has a magnification range of 10× to 40×. A light ring provides a consistent incident light source and a camera is attached for high resolution images.

SURFACE PROFILOMETRY

Surface Roughness Measurement PS50
Nanovea



Nanovea 3D Non-Contact Profilometers are designed with leading edge optical pens using superior white light axial chromatism. Nano through macro range is obtained during measurement (profile dimension, roughness finish texture, shape form topography, flatness, warpage, planarity, volume, area, step-height, depth, thickness, and others).

- Determines R_a, R_z, R_t, R_p, R_q and R_{max} values (DIN4768 and DIN4776).
- Operates in a 300 µm range with a vertical resolution and accuracy of 0.012 and 0.06 µm, respectively.
- Controllable X-Y stage with 0.1 µm resolution in each direction.
- The laser is suited to materials that exhibit variable reflectivity and geometries that sufficiently reflect the laser back to the probe; maximum measuring angle for specular samples is 28°.
- Sample scanning areas up to 50 × 50 mm.
- Adjustable z-axis to enable measurement of large components (up to 50 mm approximately).
- Adjustable stage to compensate for minor curvatures (reduced measurement area required for curvature >300 µm in height variation).

PARTICLE SIZE ANALYSIS

Multisizer 3
Beckman Coulter

The Multisizer uses a technique developed initially to measure blood cells. It analyses charge displacement within the aperture tube (the electrical sensing zone). Depending on aperture tube size it can measure particles from 0.4 – 1,200 µm. Background baseline is measured to remove external noise.

- Method based on volume of electrostatic charge displaced.
- Particle size distribution (PSD) measurement limited by the size of aperture tube chosen.
- Method assumes aspect ratio of 1 on grain shape, this factor can be changed in software.
- Range of electrolytes address potential particle solubility issues.
- Calculates PSD (D10, D50, D90 …) and gives surface area measurements.
- Automated stirring ensures particles remain in suspension.
- Sample size from mg to g.
- Powder samples.
- Minimum of 10g to enable multiple runs.

Particle Size Analyser LA 920
Horiba

The Horiba relies on light diffraction to measure the particle size distribution (PSD). The instrument is widely used for ceramic chemistry and food science measurements. Background measurements are gathered before readings. The limits of the instrument are 0.02 to 2,000 µm. No cell change is required. The LA920 has ultrasonic agitation to help with agglomeration breakdown.

- Method based on light refraction of grains.
- DI water or other suspending fluids acceptable.
- Stirring and ultrasonic agitation.
- Background baseline measured eliminating error from the carrier suspending fluid.
- 0 mg to 5 g of powder required. Amount varies depending on sample material.

SPECTROMETRY

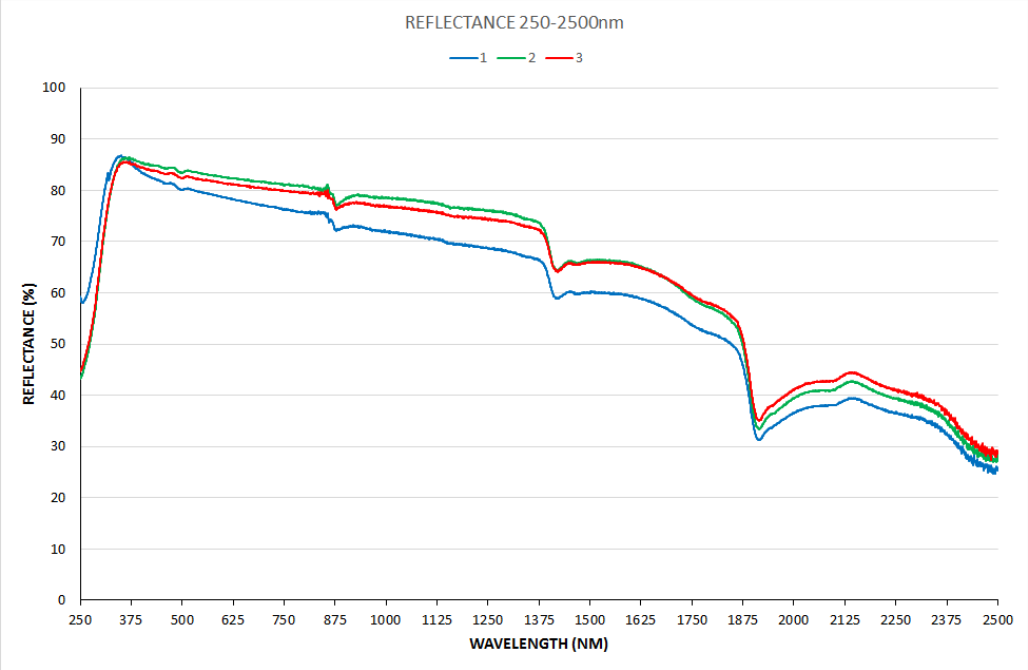
UV/Vis/NIR Reflectance Spectrometer with 6" Integrating Sphere Lambda 19
Perkin Elmer

- UV/Vis/NIR industrial spectrophotometer providing high precision.
- UV/Vis/NIR performance wavelengths up to 2,500 nm.

Operation:

- Deuterium lamp for UV range, Tungsten-halogen lamp for Vis/NIR range.
- Side window photomultiplier for UV/Vis range, PbS detector for NIR range.
- Automatic detector change during monochromator slewing.
- Spectralon reference standards are used to calibrate & baseline instrument before use (2% / 50% / 75% / 99% reflectance).

Wavelength range: 185 to 3,200 nm
Accuracy: +/- 0.2 nm (UV/Vis), +/- 0.8 nm (NIR)
Software: Lambda SPX-P (scan mode for spectral analysis)
Sample port dimension: 20 mm diameter
Sample size restriction: 100 × 100 mm (limited by holder). Solid sample must be flat. Powders may also be measured (compressed). Liquid samples cannot be measured.



VISCOSITY ANALYSIS

DV-II+Pro Viscometer
Brookfield

- The DV-II+pro viscometer is capable of standalone measurements of viscosity in cP. Fluids with viscosities ranging from 100 to 150,000 cP can be profiled over speeds from 0.5 to 100 rpm using spindle set S61-S64.
- The viscosity of the material can be studied over the above speed range and within the cP window above.
- The unit also monitors the temperature of the solution. The effect of temperature, time and speed can be logged with the current unit.
- Fluids must be inert with respect to stainless steel.

300 ml minimum required per unique test. Sample must be in liquid form.

MOISTURE ANALYSIS

5 Decimal Place Balance with Software DV215CD
Ohaus

The OHAUS Discovery series of analytical balances combine unmatched weighing performance with OHAUS' innovative SmarTextTM software, making it extremely reliable and easy-to-use. The Discovery features durable glass and steel construction and together with advanced AutoCal™ internal calibration make it the best performing balance in its class.

- SmarTextTM Software utilizes text prompts to guide users through application use and balance setup. Serial connection available.
- Multiple application modes: Weighing, Parts Counting with Automatic Sample Recalibration, Percent Weighing, Dynamic Weighing, Gross/Net/Tare Weighing, Totalisation, Density, Statistics.
- Advanced AutoCalTM automatic internal calibration ensures accurate weighing.
- Accurate to within 0.1 mg, capacity 210 g.
- Capability to measure powders, liquids and solids.

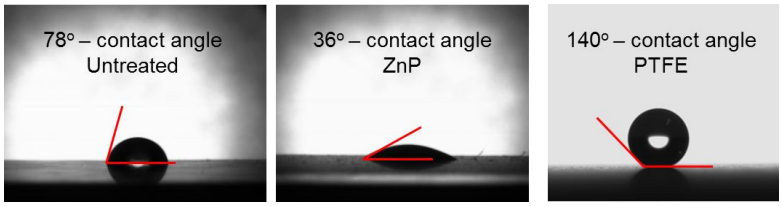
Moisture Analyser
Computrac

- Moisture | Solids Range: 0.005 to 100%.
- Moisture Resolution: 0.001% (Default) or programmable from 0.0 to 0.00000.
- Repeatability: 0.002% standard deviation depending on test program.
- Balance Resolution: 0.0001 g.
- Temperature Range: 25°C to 275°C controlled to ±1°C, nickel chromium heating element.
- Sample Size: 100 mg to 40 g (0.2 ± 0.0001 g – 39.9 ± 0.1 g).
- Rate can be set as low as 0.0010% per minute.
- Storage of up to 250 Programs (246 User, 4 Factory), Linked Test Program Capability, 1000 Test Results with last 100 test graphs.
- Statistical Analysis: Mean, Standard Deviation, Relative Standard Deviation.
- Results Display: Moisture, Solids, Dry Weight, Purity.
- Balance Calibration: Menu driven calibration and verification in the field, Programmable calibration reminder.
- Samples can be liquid or powder form.

CONTACT ANGLE TESTING

Microlitre, Liquid Contact Angle Measurement CA1
ENBIO

When an interface exists between a liquid and a solid, the angle between the surface of the liquid and the outline of the contact surface is described as the contact angle (θ). The contact angle (wetting angle) is a measure of the wettability of a solid by a liquid. In the case of complete wetting (spreading), the contact angle is 0°. Between 0° and 90°, the solid is wettable and above 90° it is not wettable. In the case of ultrahydrophobic materials the contact angle approaches the theoretical limit of 180°.



CA1 contact angle measurement system:

- Micro-litre controlled syringe pump for accurate dispensing.
- Brunel 5MP CCD video capture device.
- Measures water contact angle (through ImageJ software and EPFL drop analysis algorithm).
- For 2 µl droplets an area of 5 × 5 mm is recommended i.e. 3 drops requires a 5 × 15 mm measurement area.

The CA1 is an in-house contact angle system designed to measure micro-litre volumes of liquids on a surface. It is primarily used to determine the Water Contact Angle (WCA) but can also be used to determine surface

energy using other liquids (e.g. Diiodomethane and Ethylene Glycol).

ELECTRICAL RESISTANCE

High Resistance Meter 4339B
HP/Agilent

Compact bench top meter to provide accurate high resistance and low current tests. Used in conjunction with Agilent 16008B resistivity cell.

Features include:

- Test contact check function, parasitic error correction, 0.6% basic accuracy.
- Ability to perform charge, measure and discharge sequences.
- Built-in surface and volume resistivity mathematics.
- Pass/fail testing with built-in comparator function.
- Single, multiple, continuous measurement sequences can be programmed.

Test channels	1
Basic accuracy (%)	0.6
Test voltage levels (VDC)	0.1–1,000
Measurement parameters	R, I, ρV, ρS,
Measurement range (Ω)	10^3–1.6×10^{16}
Measurement Time (ms)	10, 30, 390
Operating range	0–45 °C/≤ 95% RH @ 40 °C
Measurement Parameter	**Range**
DC resistance (Ω)	10^3–1.6×10^{16}
DC current	60 fA to 100 µA
ρV	Up to 4.0×10^{18} Ω/cm
ρS	Up to 4.0×10^{17} Ω
Measurement Conditions	**Range**
DC test voltage (0.1 V – 1000 V)	<200 V = 0.1 V steps, >200 V = 1 V steps
Max current	10 mA @ ≤ 100 V, 5 mA @ ≤ 250 V, 2 mA @ ≤ 500 V, 1 mA @ ≤ 1 kV

Resistivity Cell 16008B
HP/Agilent

The HP/Agilent 16008B is a test fixture used in conjunction with the HP/Agilent 4338B High Resistance Meter.

It is designed to reliably and repeatedly test solid parts. It can accommodate flat thin sheets ranging in size from 50 × 50 mm up to 100 × 100 mm. 28 and 50 mm diameter electrodes are available for testing.

Max voltage (V)	1,000
Max current (mA)	10
Resistivity Measurement Range	1 µA, 10 µA, 100 µA, 1 mA, 10 mA
ρV	Up to 4.0×10^{18} Ω/cm
ρS	Up to 4.0×10^{17}
Operating conditions	0°C to 55°C / Max 70% RH @ 40°C

Low Resistance Meter 4338B
HP/Agilent

The HP/Agilent 4338B Milliohmmeter is a compact benchtop solution for precise measuring of extremely low resistances. Using an AC test signal the device provides quick, reliable results.

Functions include short error correction (eliminates errors due to parasitic impedances in cables and fixtures) and test contact check.

Test frequency	1 kHz ± 1%
Basic accuracy (%)	0.4
Test current levels (RMS)	1 µA, 10 µA, 100 µA, 1 mA, 10 mA
Impedance parameter sets	R, |Z|- Θ, R-L, R-X
Measurement time (ms)	34 – 900
Maximum applied AC voltage (mV peak)	20
Maximum DC voltage to BNC terminals (V)	42
Operating temperature (°C)	0 – 45
Measurement parameter	**Range**
R	10 µΩ to 100 kΩ
X, |Z|	10 µΩ to 100 kΩ
L	10 nH to 10 H
Θ (°)	-180 – 180°

Surface Resistance Probe Concentric Ring Probe
Vermason

The Vermason Concentric Ring Probe is an instrument to be used in conjunction with a resistance megohmmeter, such as the Vermason 222643 Digital Surface Resistance Meter, to measure surface resistance per IEC 61340-2-3, the test method listed in Packaging Table 4 in EN 61340-5-1.

The Concentric Ring Probe can measure the volume resistance of planar materials using a flat conductive metal plate (not included). The Concentric Ring Probe may be used for the resistance measurements of ESD packaging including static shielding and other bags. Accuracy determined by the equipment used to take the reading. HP4339B used for this purpose.

SURFACE RESISTANCE

4-point Probe Surface Resistance Scanner Sherrescan 9000
Mechatronic

Used to measure and map sheet resistance. Can provide a visual representation of the sheet resistance across the whole sheet. The machine can be run open or closed depending on requirements. The Sherescan 9000 can also be used to determine the resistivity if the sheet thickness is known. Uses a Jandel 4-point probe mounted on a computer controlled positioning system.

Measurement accuracy	0.5% (electric uncertainty)
Measurement range (Ω/sq)	10 – 200
Wafer fixation	Vacuum bed

Material	Tungsten Carbide (WC)
Needle spacing (µm)	63.5
Load (per needle) (g)	100
Needle radius (µm)	100
Sample sizes	
Thicknesses (µm)	200 – 1,000
Length (X – axis) (mm)	25 – 215
Width (Y – axis) (mm)	40 – 215
Sample shape	Circular, square, rectangular

THICKNESS TESTING

Ultra-sonic Thickness Probe for Non-ferrous Substrate / Non-conductive Coatings
Positector NAS6000
DeFelsko

The Positector is a portable thickness measurement probe for measuring thickness of non-conducting coatings on non-ferrous substrates. Information can be read off directly or transferred to a PC via USB, Bluetooth or Wifi.

Positector 6000 NAS3 thickness probe specifications:

- NAS probe for measuring thin non-conductive coatings on non-ferrous metal substrates.
- 16 mm diameter probe.
- Range: 0 – 625 µm or 0 – 25 mils.
- Accuracy: + (0.02 mils + 1%) 0 – 4 mils and + (0.1 mils + 3%) > 4 mils; + (0.5 µm + 1%) 0 – 100 µm and + (2 µm + 3%) > 100 µm.
- Conforms to: ISO 2178/2360/2808; PrEN ISO 19840; ASTM B499 / D1186 / D1400 / D7091 / E376 / G12; BS3900-C5, SSPC-PA2 and others.

OVENS

Drying Ovens Fitted with Eurotherm 2408 P4 Controller OV/200
GenLab

Large capacity fan assist alumina coated mild steel chamber (200L):

- Internal size 750mm × 490mm × 540mm.
- Programmable heating/dwell/cooling stages with Eurotherm 2408 controller. Looping program capability.
- Maximum temperature 250°C. Heating rates from 0.3 – 10°C. Dwell times to 999 minutes (approximately 16 ½ hours per profile segment).
- Fan assisted circulation.
- Over-temperature protection.
- Accurate to within 0.75°C.

Drying Oven Fitted with Eurotherm 2404 P4 Controller Plus II
Gallenkamp

Large capacity Stainless Steel Chamber (150 L volume):

- Internal Size 460 × 460 × 660 mm.
- Programmable heating/dwell/cooling stages with Eurotherm 2404 controller. Looping program capability.
- Operational temperature from 40 to 300°C. Heating rates from 0.2 – 10°C. Dwell times to 999

minutes.
- Fan assisted circulation.
- Over-temperature protection.
- Accurate to within 0.5°C

HUMIDITY OVENS

Constant Climate Humidity Chamber HCP108 Memmert

The Memmet constant climate humidity chamber offers precisely controlled atmospheres with a humidity working range or 20 – 90% RH.

- Stainless Steel internal chamber.
- Programmable profiles including rates times and dwells.
- Chamber dimensions 560 × 480 × 400 mm.
- Humidity chamber operates in humidity mode up to 90°C, with the operating window ranges listed below:
  - At temperatures up to 55°C the humidity levels can be controlled to 30 – 95 relative humidity (RH).
  - Between 55°C and 90°C the humidity levels can be controlled to 30 – 70 RH.
- Operates in non-humidity mode up to a maximum 160°C.
- Temperature sensors Pt100 Class A in 4-wire circuit for uninterrupted operation on failure of one Pt100 with warning indication, controlling temperatures within the chamber to < ± 0.3°C.

Humidity-Controlled Environmental Chamber KBF 720 Binder

The inner chamber, preheating chamber and outside doors are all made from stainless steel. The chamber is fitted with inner glass sealing doors. The chamber is capable of operating in Humidity, and Temperature modes.

- Chamber operating conditions 0–70°C, and humidity ranges from 10–90% RH.
- Microprocessor controlled humidifying and dehumidifying systems.
- Operates in manual or automatic mode.
- Stores multiple programs (>30). Each program consists of cycles, ramps, dwell times, internal and external loops.
- Internal Dimensions: 973 ×1,250 × 576 mm.
- Internal volume 700 litres.

Large Humidity Environment (95% RH to 50˚C) and Drying Oven (250˚C) Caltherm

- Eurotherm 3504 controller – fully programmable.
- Internal capacity 2 × 2 × 2 m.
- Humidity control to 70°C.
- Humidity range from 30 to 99 RH.
- Maximum temperature: 250°C.
- Uniform temperature control to within ± 1°C.
- Maximum heating rate: 5°C/min,
- Minimum heating rate: 0.1°C/min.
- Tested cooling rate: 0.5°C/min above 80°C.

- Below 80°C cooling rate decreases to approximately 0.1°C/min due to the level of insulation present in the oven.

FURNACES

High Temperature Furnace (1300 °C) FSG-115-020L
Fisher Scientific

The Fisher Muffle furnace has a Digicon controller and 24 hour timer to run controlled and extended heating cycles. The Muffle door allows for ease of access and transfer of materials in and out of the chamber.

Fisher Muffle Furnace Specification:
- Rated temperature 1,000°C.
- Heat-up time 110 minutes.
- Temperature distribution at centre axis, K† ±10 °C.
- Work space volume: 3.5 litres.
- External dimensions (w × d × h): 456 × 570 × 646 mm.
- Work space dimensions (w × d × h): 170 × 160 × 130 mm.

Furnace with Eurotherm 2408 Controller ESF 12/5
Carbolite

A standard box furnace with a maximum temperature of 1,200°C and internal dimensions of 125 × 125 × 250 mm. The controller allows manual or automatic temperature control, as well as full multistage programming of temperatures, ramp rates, and dwell times.

Large Electric Furnace (2 × 2 × 2 m Internal Volume)
Caltherm

- Eurotherm 3508 controller - fully programmable.
- Internal capacity 2 × 2 × 2 m.
- Maximum temperature: 500 °C.
- Uniform temperature control within the oven to ± 1 °C.
- Maximum heating rate: 5 °C/min.
- Tested cool down rate of 0.5 °C/min to 100 °C.
- Below 100 °C cool down rate drops to 0.1 °C.

TENSILE TESING

MultiTest 10-I
Mecmesin

The Mecmesin MultiTest 10-I is a powerful twin column tensile and compression test system capable of conducting high capacity force measurements up to 10 kN. The accompanying Emperor Software provides full programming capabilities and offers great versatility in analysing your test results. The user-friendly graphical interface gives customers full control over the tensile tester program and analysis. Features such as load cell auto detection, run to load, time, displacement or break detection make performing tensile and compression tests simple and easy and allows the user to extract very useful

information at the touch of a button. Tests which can be provided include, but are not limited to, lap shear tests, friction tests, peel tests, three point bend tests, etc.

Test Frame	Rated capacity:	10,000 N
	Number of ballscrews	2
	Speed range	1 – 1,000 mm/min
	Crosshead speed accuracy	±0.1% of indicated speed
Dimensions	Distance between columns	400 mm
	Height	1,500 mm
	Width	826 mm
	Depth	512 mm
	Weight	110 kg
	Max power requirement	400 W
	Voltage	230 V AC 50 Hz or 110 V AC 60 Hz
Load Measurements	Loadcell ranges	100-10,000 N
	Loadcell measurement accuracy	±0.1% of full scale from 100 – 2,500 N
		±0.2% of full scale from 5,000 – 50,000 N
	Loadcell measurement resolution	1:6,500
	Load cells in stock	100 N, 1,000 N, 5,000 N
Displacement	Crosshead travel	960 mm
	Position control resolution	±0.01 mm
Software	Digital display of load/length/speed	Yes
	Sampling rate	1000Hz, 500Hz, 100Hz, 50Hz, 10Hz
	Secondary input	Event Input (switch), Digital Control I/O ports

3D PRINTING

Filament 3D Printer (200 × 200 × 250 mm Area) CraftBot Craftunique

The Craftbot is a small form lab scale printer. This is used for prototyping nozzle and sample fixtures as well as building models for part features (geometries and curvatures) to test the robotic CoBlast programs.

- Single Extruder, Fused Filament printer.
- Build volume: 250 × 200 × 200 mm.
- Layer resolution: 100 µm (high), 200 µm (medium), 300 µm (low).
- Print speed: 50–200 mm/s.
- Position precision: X,Y: 4 µm, Z: 2 µm.
- Filament materials: HIPS, PLA, ABS, Flex, Lay Wood, Laybrick.
- Build formant: OBJ/STL/CWPRJ.