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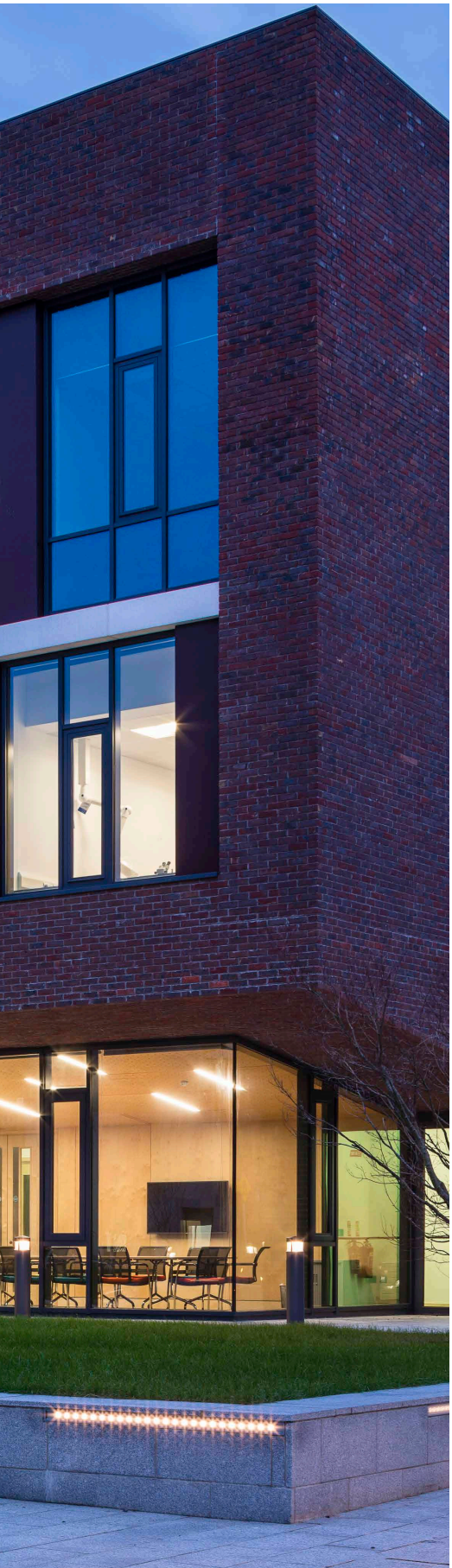
Dublin City University

DCU Nano Research Facility

Nano Research
Facility



Introduction

The Nano Research Facility at DCU aims to enhance and support research within academia and industry by providing open access to high end, state-of-the-art scientific equipment.

It is staffed by an experienced team of Research Technical officers, thus enabling DCU researchers, visiting research teams and industry to collaborate in state-of-the-art labs, augmenting the process of bringing research from concept through to final prototyping and ultimately, commercialisation.

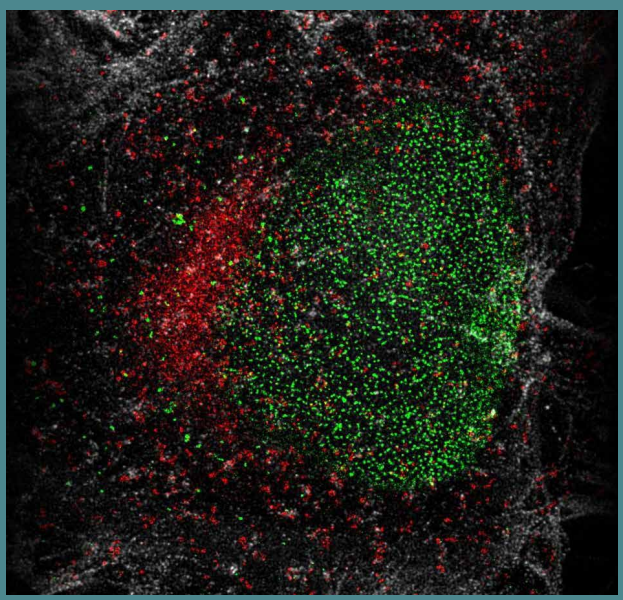
Microscopy

Confocal and STED Super Resolution Microscopy

The **Leica TCS SP8 STED** super-resolution microscope is based on the Stimulated Emission Depletion principle developed by Nobel Prize laureate Stefan Hell. Fluorescence images are produced by scanning a fluorescently stained sample with an effective reduced area of illumination. The area of illumination is effectively reduced by the selective deactivation of fluorophores by stimulated emission depletion, which delivers the ability to image structures below the diffraction limit ~ 50nm. Suitable for use in biological and biomedical research, and material science applications.

The STED system is installed on a low vibration platform to reduce noise, improving high resolution image quality. Notable features of the system are:

- Whitelight laser for confocal excitation from 470 nm to 670 nm – up to 8 lines simultaneously
- Pulsed 405 nm laser for confocal excitation
- 660nm and 592nm depletion lasers for super resolution imaging of a large range of fluorophores
- PMT & HyD Single Molecule detectors for confocal, STED and lifetime imaging (FLIM, FCS)
- Resonant scanner for imaging at 24 frames per second
- Galvoflow, SuperZ galvanometer stage for fast scanning in Z



STED image of HeLa cells. Green: NUP153-Alexa 532, Red: Clathrin-TMR, White; Actin-Alexa 488.
Image courtesy of Leica Microsystems.

Widefield Fluorescence Microscopy

The **Olympus IX81** microscope is a high speed motorized inverted fluorescence microscope with high resolution DIC and phase contrast optics and colour CCD camera with a broad range of filter sets. It is ideal for live and fixed cell fluorescent imaging and imaging of fluorescent materials.

Atomic Force Microscopy

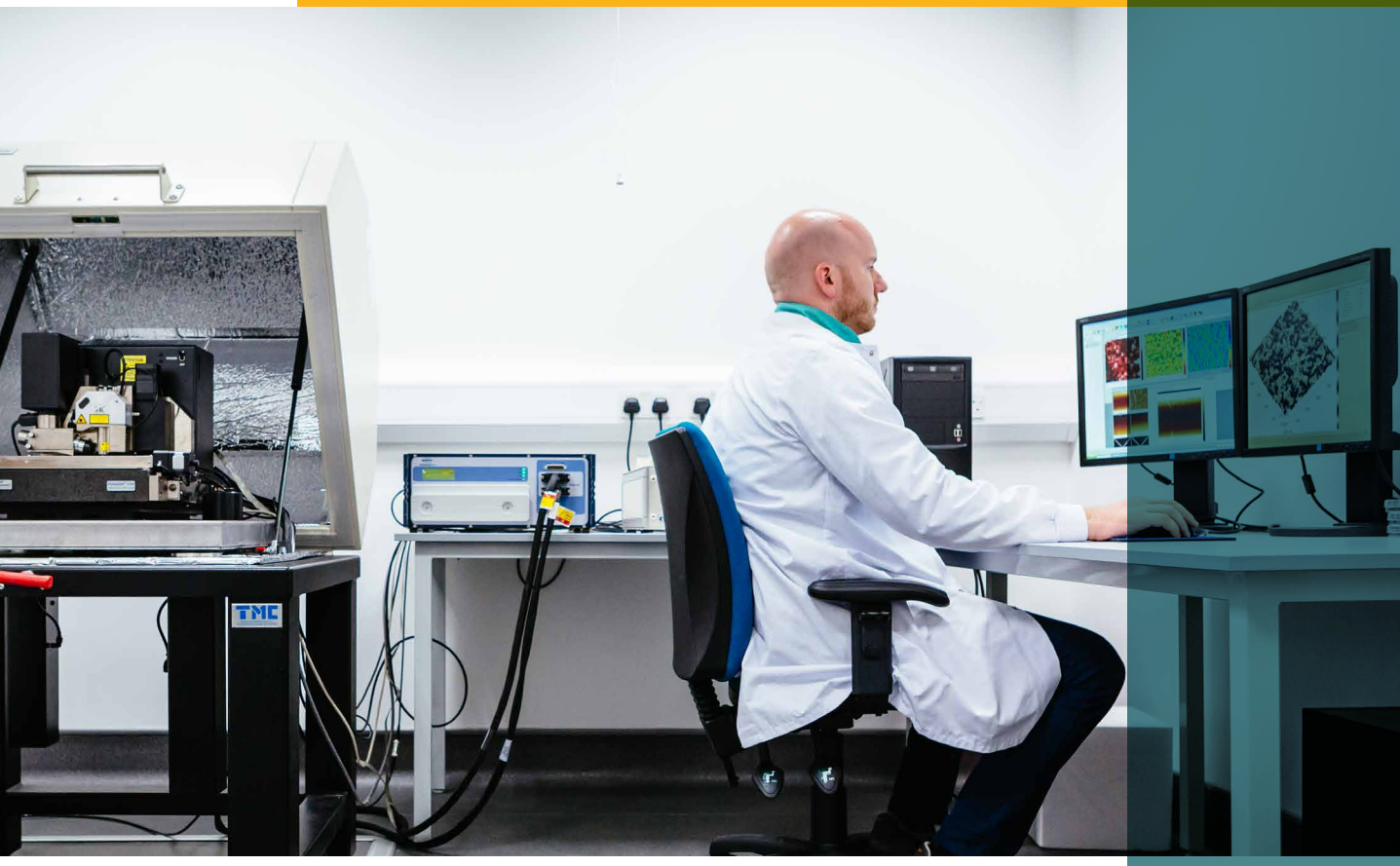
Atomic force microscopy allows for topological imaging of surfaces on the micro and nano scale. As it operates in air, sample preparation is minimal and the instrument is suitable for a large range of applications from Polymers to Biological Specimens, Biomaterials, Metal, Thin Films and Ceramics.

The **Dimension 3100 AFM** is a flexible atomic force microscope, equipped with a NanoScope V controller. Various imaging modes are possible, to suit a wide range of applications:

- Contact mode
- Tapping mode
- Phase imaging
- Lateral force mode
- Force imaging
- Magnetic force mode

The **Dimension ICON AFM** provides additional AFM capabilities with low noise and high speed imaging. The advance control hardware provides quality images in a fraction of the time. This system has two additional imaging modes; Peak Force Tapping and Quantitative Nano Mechanical Mapping, which can provide height images and mechanical properties maps at the same time. With probe calibration it is possible to get absolute values for:

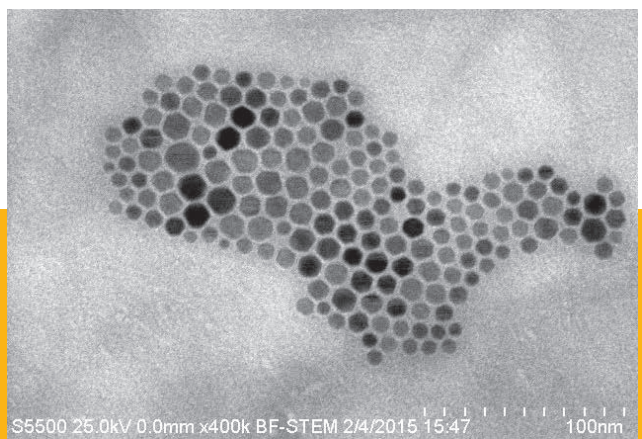
- Height
- Young's Modulus
- Deformation
- Adhesion
- Dissipation



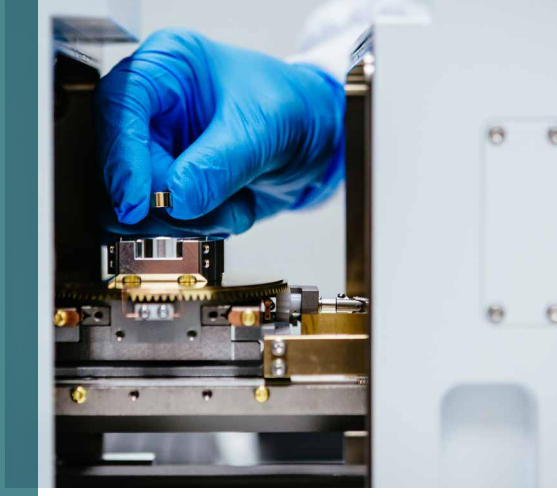
Both of our AFMs are housed in isolation hoods and installed on low vibration platforms to reduce noise and drift, improving the image quality.

Electron Microscopy

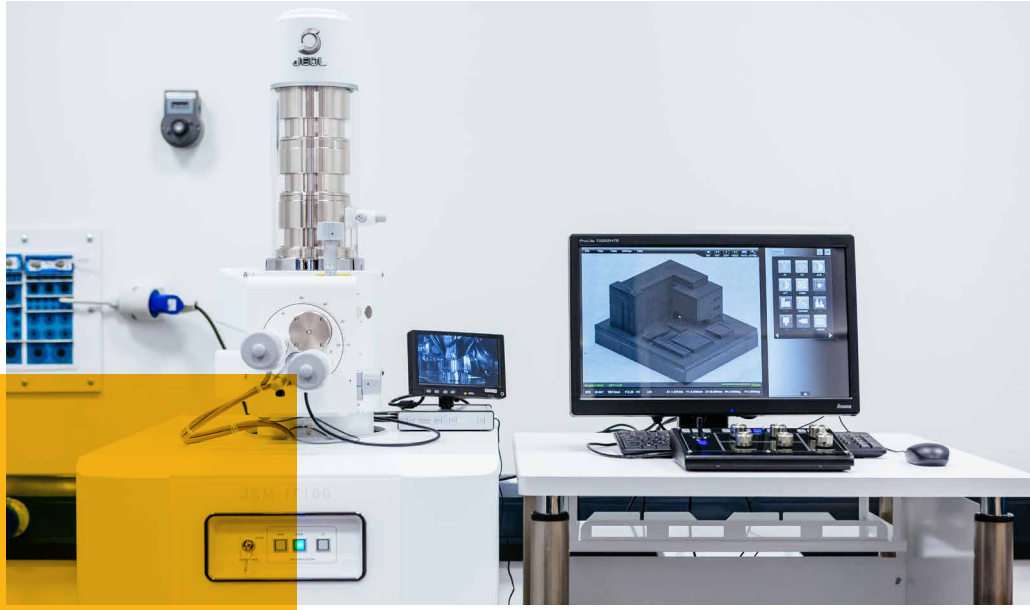
The **Hitachi S5500 Field Emission SEM** is an Ultra-high Resolution SEM, capable of scanning and transmission imaging modes. It can achieve a maximum magnification of 2,000,000 X which can provide an imaging resolution better than 2 nm. The system is installed on a low vibration platform, improving the signal to noise in the image, and therefore the quality of the images. Typically used for the imaging of nanoparticulate materials, this microscope is also suitable for samples in Life Science, Materials Science and Semiconductors. It also has an EDX detector for elemental analysis.

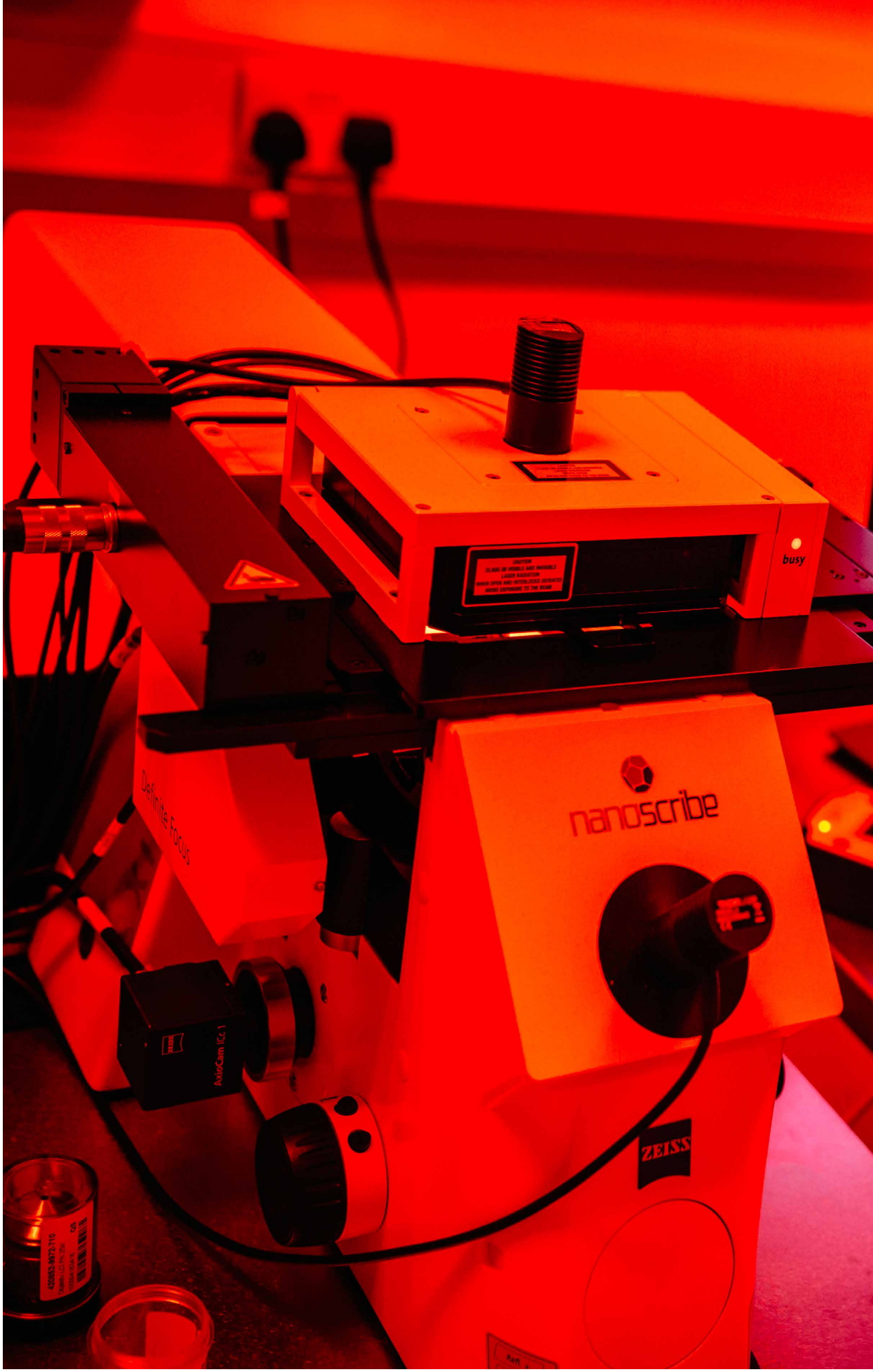


SEM image of Iron Nanoparticles
10 – 20nm in diameter



The **JEOL JSM-IT100** is an SEM with a large sample chamber which allows for a wide range of sample types. It is capable of high pressure operation which enables easy imaging of nonconductive samples without the need for conductive coatings with an achievable imaging resolution of 10 nm. Intended to be a general purpose instrument, inspection of samples can be carried out with a quick turnaround and minimal sample preparation. This system is also installed on a low vibration platform, improving image quality.

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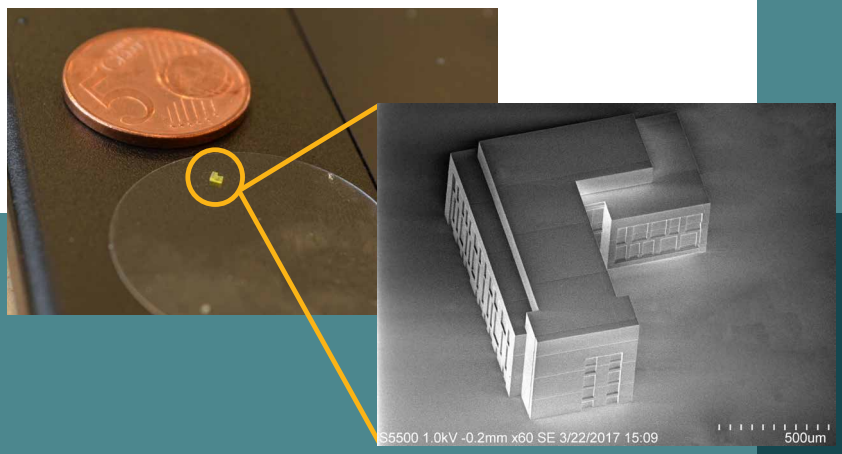
ZEISS
Definite Focus
AxioCam ICc 1

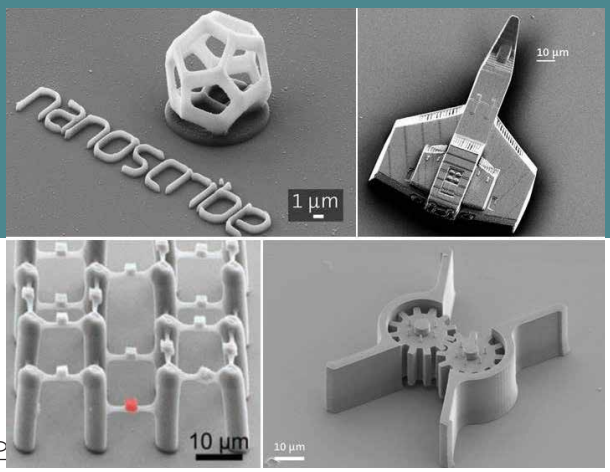
Nanoscribe Photonic Professional
2 photon lithography system

3D Fabrication

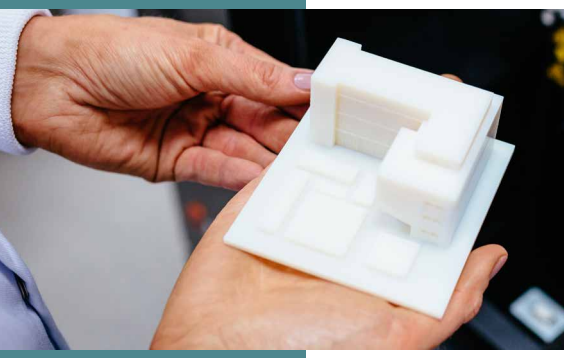
Nanoscribe

The **Nanoscribe Photonic Professional GT** 3D Laser Lithography System is the highest resolution commercially available 3D printer. The system utilizes "direct laser writing" two-photon polymerisation of various UV-Curable photoresists to fabricate complex shaped structures. The laser is focused into the resin and the two-photon polymerization (TPP) is triggered only in the focal spot volume. It can produce fine feature sizes down to 200 nm with optical quality surface finishes. Features can be printed within a working area of 127mm in the X and Y. The applications are wide ranging and include Optics, Photonics, Biomedical Engineering, Biomimetics, Microfluidics and Mechanical Microstructures.





2 Photon printed model of NRF building, printed with the Nanoscribe and imaged with the Jeol SEM.

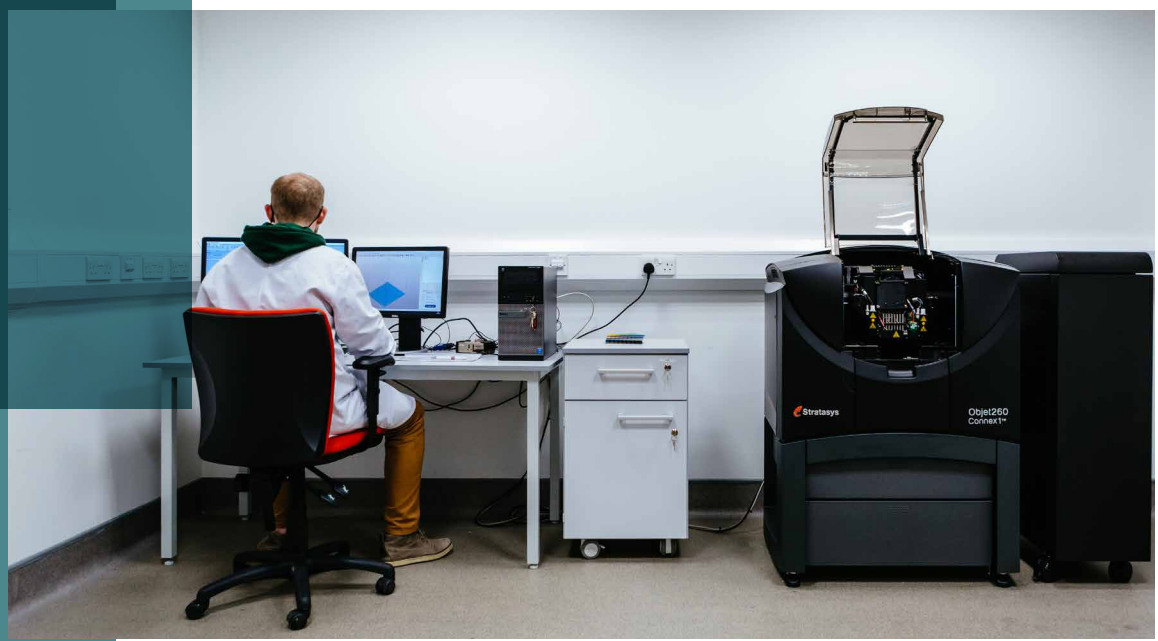


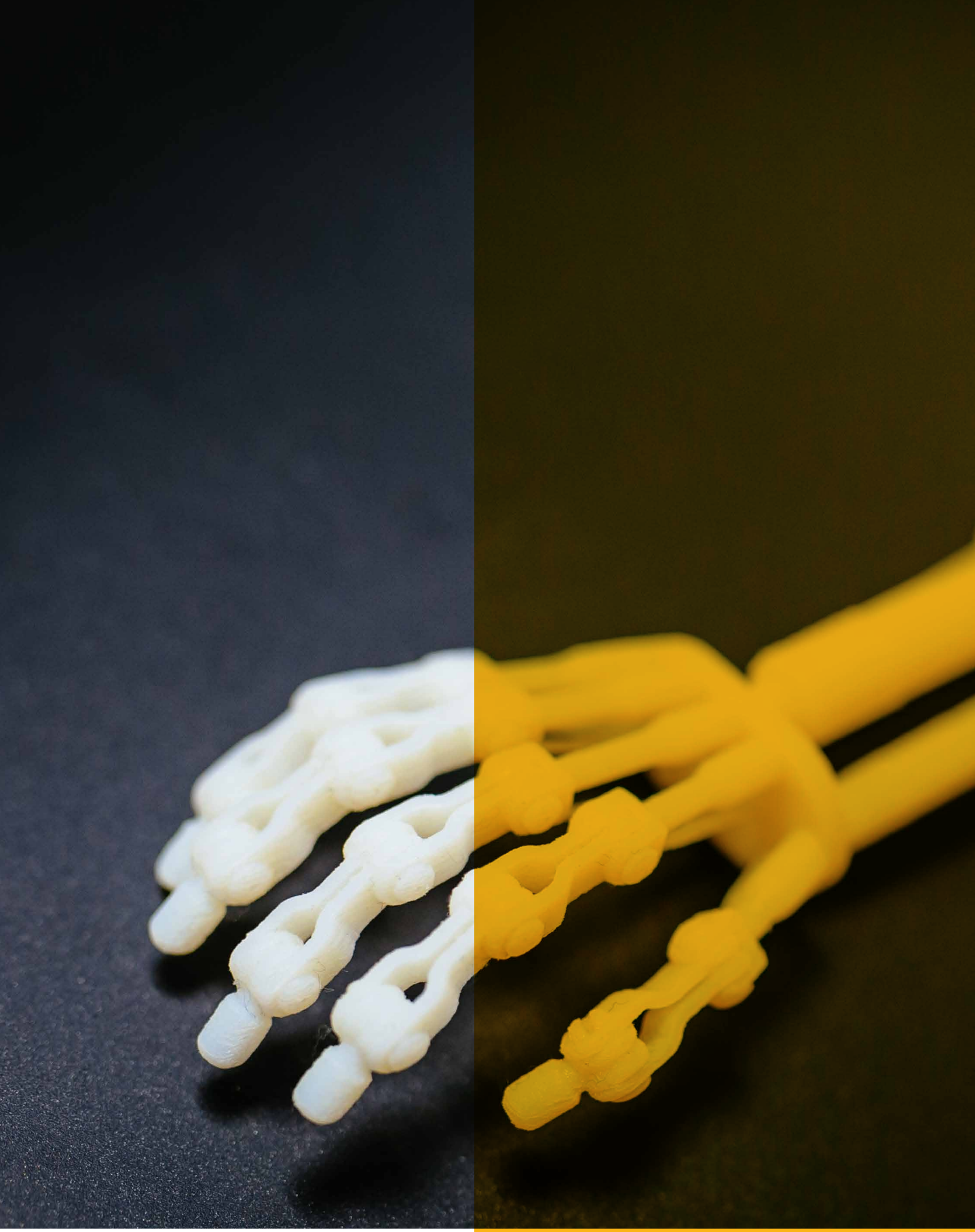
Additive Manufacturing Systems

Additive manufacturing is used to create 3D objects by adding material layer by layer. Objects of almost any shape or geometry can be made using model data.

The **Stratasys Objet260 Connex1** allows printing of three-material models as large as 255 × 252 × 200 mm in the X, Y and Z respectively, with a 16 µm layer accuracy. The 14 photopolymers available simulate a range of material properties.

The **Stratasys Dimension UPrint** is a workhorse printer producing high quality parts as large as 203 x 152 x 152 mm in X, Y and Z, using 0.254 mm slices. It uses soluble support material which means the finished parts are quickly cleaned with the built-in wavewash system.





3D printed Terminator arm with moveable joints (Connex1)

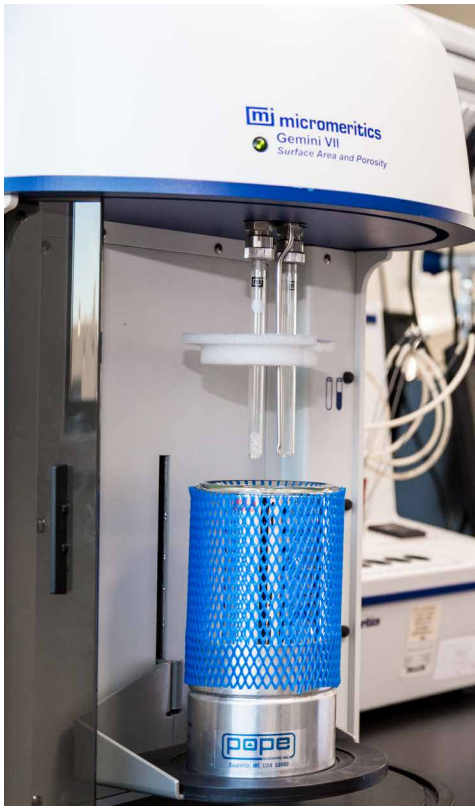
The **Dolomite Fluidic Factory** 3D printer prints fluidically sealed devices with leak-free flow paths. This printer uses chemically and biologically compatible COC (Cyclic Olefin Copolymer), a hard, translucent and FDA approved polymer for implantables and is ideal for a wide range of applications. It can produce 3 dimensional mixers, non-rectangular chips, unique channel geometries and features not possible using etching, embossing, molding or machining.

Additional Fabrication Facilities

The fabrication suite in the NRF also includes:

- Epilog Zing Lasers and Graphtec Cutters for patterning of various polymer substrates and precision cutting.
- Roland Milling Machine which provides 3D milling for highly accurate microfluidic and prototype devices.
- Chem Instruments Laminator for reliable bonding of microfluidic devices.
- A dedicated HEPA filtered assembly room for assembling devices in a clean environment.

Materials and Surface Analysis



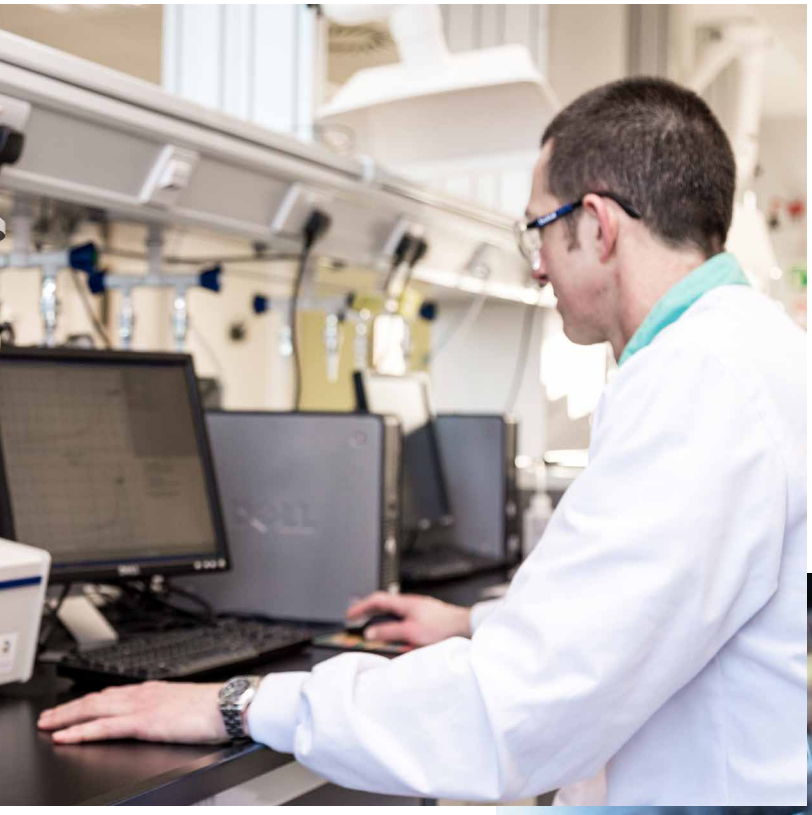
Particle analysis

The Particle Analysis suite in the NRF is suitable for characterising particles in a range of sizes and materials using a number of different techniques:

The **Malvern Mastersizer 3000** is a laser diffraction particle size analyzer that can measure particle size distributions for both wet and dry dispersions. It is capable of measuring particles from the nanometer to millimetre size ranges.

The **Beckman Coulter Delsa Nano C** is a combined particle size and zeta potential analyser capable of measuring particles from 0.6 nm to 7 µm. It can be used in a wide range of applications; emulsion and formulation stability, biotechnology, shelf-life studies, pharmaceuticals.

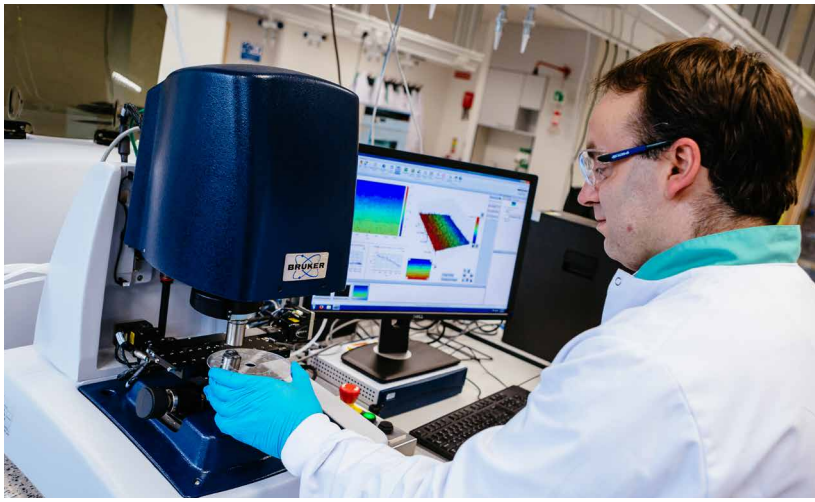
The **Micromeritics Gemini VII** is a BET analyser that can measure the surface area and porosity of particles with accurate and repeatable results.




APPROX. VOL.
800
400
200

Profilometry

Profilometery can be used on an array of sample types for surface inspection, feature dimensions, step height and roughness measurements. A **Bruker Dektak XT Stylus Profilometer** and a **Bruker Contour GT Optical Profiler** are available, both of which have a large range of applications. The Contour GT has a resolution of 1.5 µm in the X and Y, and sub nm in Z. The Dektak has a resolution of 20 nm in the X and Y and sub 5 nm in the Z. Both systems can be used for thin film inspection, surface roughness verification, verification of design and performance of microfluidic devices and other 3D printed structures.

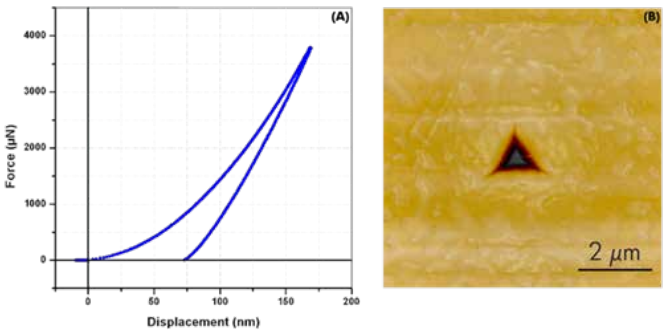


The **Keyence 3D Digital Microscope** is an inspection microscope that incorporates three-dimensional image capture, image stitching, and quantification capabilities to capture details and produce images not attainable by traditional optical microscopy. It has the ability to scan an object through multiple focal planes and compile this data into a three-dimensional image that is entirely in focus. Its large magnification range (0.1X – 5000X) together with the 3D visualization allows imaging of features at a level of magnification that can't normally be obtained.

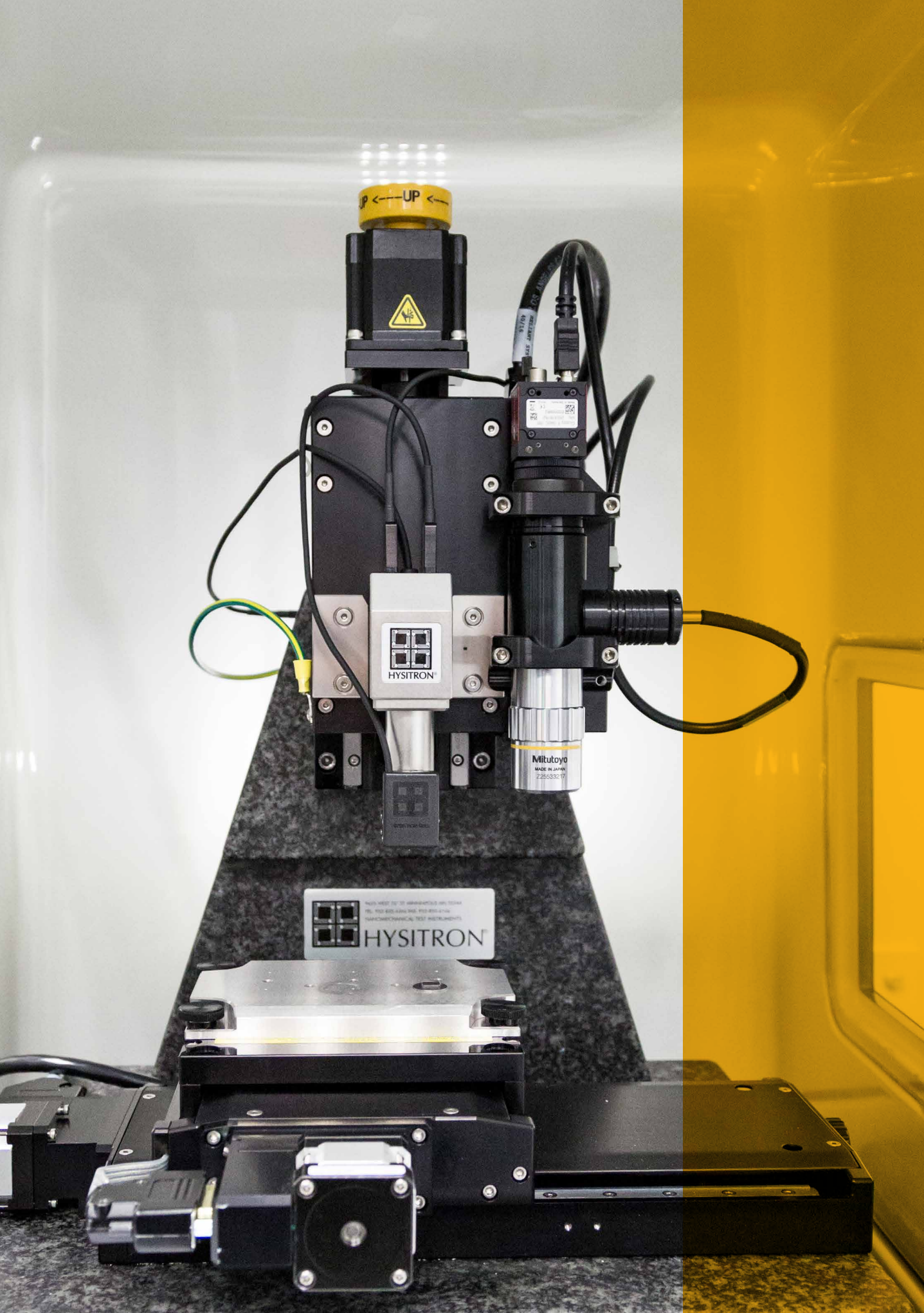

KEYENCE

Nanoindentation

The **Bruker HYSITRON TI Premier** is an automated nanomechanical test instrument for measuring the hardness, elastic modulus, fracture toughness and other mechanical properties using controlled nanoindentation of materials. Imaging of indentations is then carried out with the indenter head or the integrated optics. The system is installed on a low vibration platform, improving measurement quality. It has a range of applications such as investigating the mechanical behaviour of surfaces and ultra-thin coatings, measuring the modulus and mechanical properties of interfaces and individual phases, measuring the viscoelastic properties of polymers and biological materials on size scales down to the cellular level.



Load/unload curve and SPM image of indentation.
Image courtesy of Bruker.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MADE IN JAPAN
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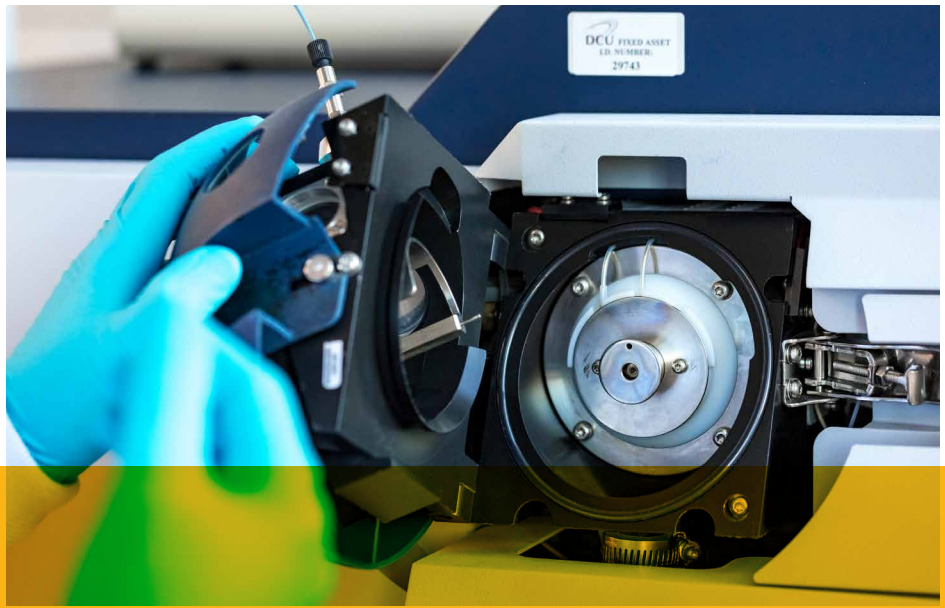
Spectroscopy and Spectrometry

The Spectroscopy & Spectrometry suite in the NRF includes:

A **Bruker HCT Mass Spectrometer** which has a high capacity ion trap Mass Spectrometer with ElectroSpray Ionization for ionizing samples in solution and is coupled to a High Pressure Liquid Chromatography system (HPLC-MS). Separation and detection of a huge variety of analytes is possible, both biological and chemical in nature, with the mass spectrometer allowing the determination and elucidation of the elemental composition and chemical structures of the analyte.

Circular Dichroism Spectroscopy (CD) can provide researchers with structural information of biomolecules and synthetic biomimetic polymers. The CD spectrometer available in the NRF is the **Applied Photophysics Chirascan Plus**. It is capable of measuring Circular Dichroism, Fluorescence, UV-VIS absorbance, temperature and multi-wavelength thermal melt analysis of samples.



Also available in the spectroscopy suite:

- Perkin Elmer Spectrum Two FTIR & Thermo Scientific Nicolet 6700 FTIR
- Shimadzu UV-2600 & UV-1800 UV-VIS Spectrophotometers
- Perkin Elmer LS55 Fluorescence Spectrometer

Equipment Access Options

Autonomous Use

— Researchers undergo full training and evaluation on equipment

— Users can book and use the instruments autonomously

— Technical support available as required

— Charges based on hourly rates

Services

— Work is carried out by the technical staff in the NRF

— Surfaces, Particle and Elemental analysis

— Includes Method Development, Data Acquisition, Data Analysis, and Reporting

— 3D Printing/Additive Manufacturing and Microfabrication

— Charges are calculated for each job

Solutions

Providing consultation and technical advice, for example:

— On microscopy and various techniques for image analysis

— For additive manufacturing print strategies

— On elemental, structural and mechanical properties analysis

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EUROPEAN UNION
European Regional Development Fund

Ireland's EU Structural Funds
Programmes 2007 - 2013
Co-funded by the Irish Government
and the European Union

An Roinn Post, Fiontar agus Nuálaíochta
Department of Jobs, Enterprise and Innovation

HEA HIGHER EDUCATION AUTHORITY
AN tÚDARÁS um ARD-OIDEACHAS

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