Imaging Suite
Who We Are and What We Do

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The Imaging Suite offers access to a wide range of both expertise in surface science and analytical facilities including TEM, SEM, XRD, AFM, Micro-CT, optical microscope and, coming soon, RTI (Reflective Transformation Imaging).

Whether it is student projects, academic research, or commercial and industrial issues, we offer a full consultation service from initial project concept through to final delivery.

We work across disciplines and across campuses, in industry and the private sector to develop awareness, capability, engagement application and advancement of surface and interface science.

Transmission Electron Microscopy
TEM

1M X magnification!

TEM uses electrons which are transmitted through a very thin sample to form an image.

What TEM can do

- ✓ Full morphological characterisation
- ✓ Grain boundary and interface
- ✓ Grain size
- ✓ Defects and their nature
- ✓ Secondary phase distribution
- ✓ Crystallographic, atomic structure
- ✓ Chemical composition
- ✓ Energy Dispersive X-ray spectroscopy (EDS)

High Resolution TEM **Diffraction Pattern**

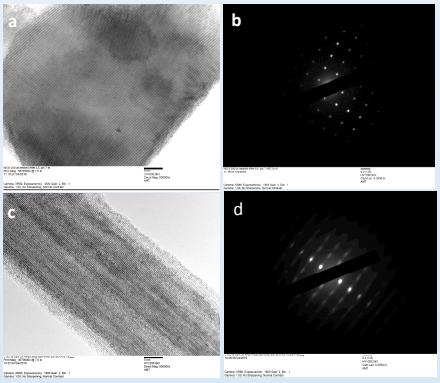

Fig. 1 (a) TEM image from WO_3 nanoparticles, (b) diffraction patterns from WO_3 nanoparticles, (c) TEM image from WO_3 nanorods and (d) diffraction pattern from WO_3 nanorods.

TEM Imaging **Elemental Line Scanning** **Elemental Mapping**

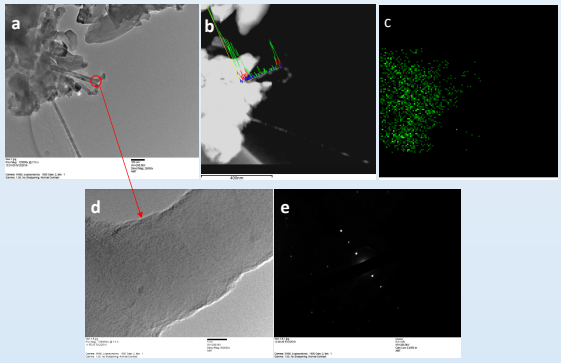

Fig. 2 (a) TEM image from SiC fibres, (b) line elemental analysis from the SiC fibre, (c) elemental mapping of Si in SiC fibre, (d) high resolution image from Fig. 2a and e diffraction patterns from Fig. 2d.

Scanning Electron Microscopy
SEM

SEM produces an image by using an electron beam that scans the surface of a sample. Range of materials: plastics, metals, wood, biological materials, cellulose, nano technology, etc.

What SEM can do

- ✓ Topography and morphology
- ✓ Elemental analysis (EDX)
- ✓ Crystallography
- ✓ Orientation of grains
- ✓ Backscatter and secondary electron imaging

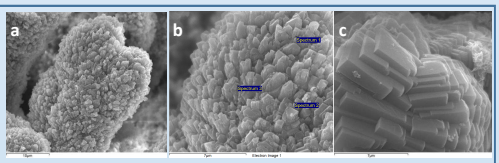

Fig. 3 (a, b and c) SEM images from fish waste showing calcium and magnesium minerals.

EDX(Energy Dispersive X-ray Spectroscopy)

Spectrum	In stats.	C	O	Na	Mg	Ca
Spectrum 1	Yes	20.34	61.68	1.22	0.01	16.75
Spectrum 2	Yes	15.73	56.15	0.11	0.09	27.92
Spectrum 3	Yes	20.99	64.75	0.25	-0.01	14.03
Mean		19.02	60.86	0.52	0.03	19.57
Std. deviation		2.87	4.35	0.60	0.05	7.36
Max.		20.99	64.75	1.22	0.09	27.92
Min.		15.73	56.15	0.11	-0.01	14.03

Table. 1 EDX elemental spectrum detail from selected points in Fig. 3b.

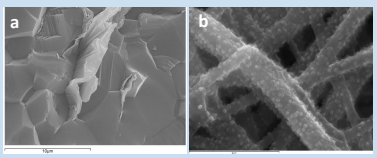

Fig.4 (a) SEM image from fractured surface of Al_2O_3-graphene composite showing rolled graphene flakes around Al_2O_3 grains, (b) carbon fibres coated with carbon nanotubes.

Micro-Computed Tomography
Micro-CT

Micro-CT is a non-invasive, non-destructive imaging technique permitting the visualisation and quantification of the interior structure of an object in three dimensions. Micro-CT generates cross-sections with pixel sizes in the micrometre range for high resolution imaging.

What Micro-CT can do

- ✓ 3D images can be animated
- ✓ Images can be converted into CAD and used in a CNC or rapid prototype printer
- ✓ Distinguish between different densities of material
- ✓ Can look for fractures, voids, porosity, manufacturing problems

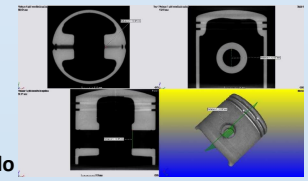

Fig. 5 X-ray cross section of a broken piston at different orientations. A 3D model for CAD remanufacture in CNC or rapid prototype.

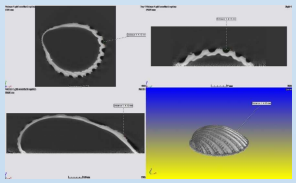

Fig. 6 Sea shell image with a cross section area to count growth lines.

Atomic Force Microscopy
AFM

AFM is an example of high resolution scanning probe microscopy, which digitally images a surface to determine the topography or roughness of a sample.

What AFM can do

- ✓ Surface topographical imaging in air and liquid.
- ✓ Force measurements (Surface energetics, electrostatics, etc.)
- ✓ Hardness, Young's Modulus, Phase Mapping
- ✓ Functional probing
- ✓ Micro-thermal analysis

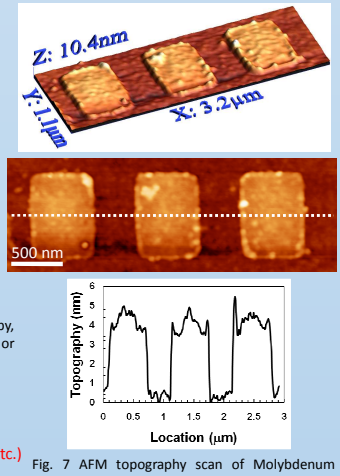

Fig. 7 AFM topography scan of Molybdenum rhenium superconducting islands with 4.5nm thickness.

X-Ray Diffraction
XRD

XRD uses the intense reflected X-ray radiation from a sample to identify phase composition and crystallographic features.

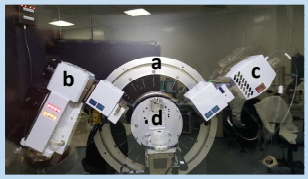

Fig. 8 **a**: The goniometer; the platform that holds and moves the sample, optics, detector, and/or tube

b: X-ray Tube; Generates the X-ray

c: Detector; Count the number of X-rays scattered by the sample.

d: Powder specimen

What XRD can do

- ✓ Phase composition and quantitative phase analysis
- ✓ Crystal structure
- ✓ Crystal size
- ✓ Grazing incident
- ✓ XRR (x-Ray Reflectometry)

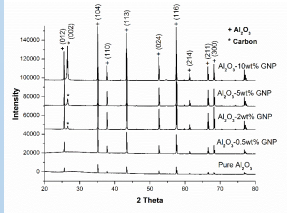

Fig. 9 XRD pattern of pure Al_2O_3 and Al_2O_3-graphene nanocomposites showing corundum crystal structure (Each peak represents a specific crystallographic plane which is indexed).

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