# Research facilities available to the Centre for Advanced Functional Materials and Devices (CAFMaD)

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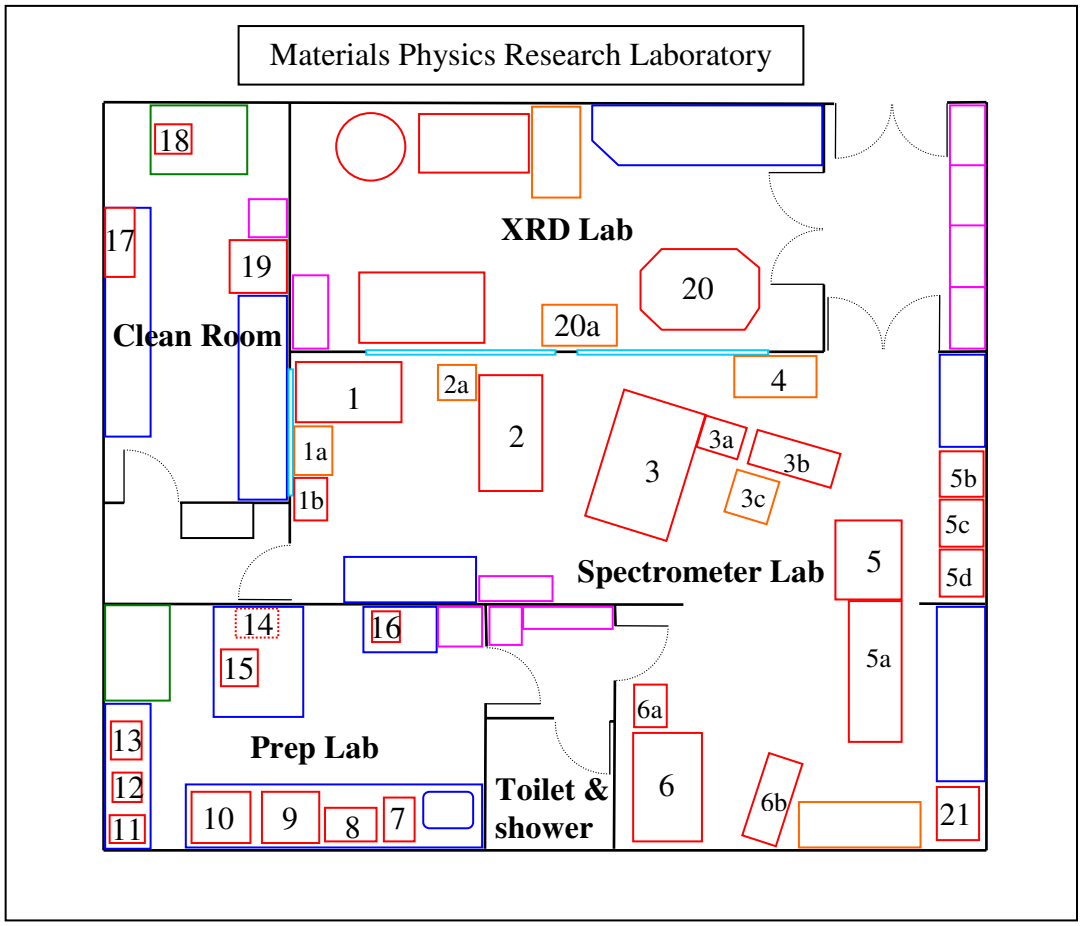
The Centre for Advanced Functional Materials and Devices has been developed to coordinate and undertake research into novel approaches to the development, characterisation and application of nano and macro materials in conjunction with computer modelling and visualisation techniques. The Centre will address priorities in the Welsh Assembly Government's 'Winning Wales' strategy for economic development by regular and deep engagement with the business community, both in Wales and internationally.

A diverse range of facilities are available for research undertaken as part of the CAFMaD collaboration. This equipment is located predominantly on the campuses of Aberystwyth and Bangor Universities but some equipment and facilities are situated elsewhere. This document lists the main facilities and items of equipment available to researchers. For further information about any item of equipment or for enquiries about making use of the facilities please contact the person specified in each section or item of equipment.

Please contact Matthew Gunn (mmg@aber.ac.uk) for any amendments or alterations to this document.

# Aberystwyth University
# Institute of Mathematics & Physics




Red: Equipment & Instrumentation
Dark Blue: Fitted Benches
Green: Fume Cupboards
Orange: Movable tables & benches
Pink: Storage

The UWA Institute of Mathematical and Physical Sciences, located on Penglais campus in Aberystwyth, is equipped with a diverse range of research instrumentation and facilities. This equipment is situated in various parts of the Institute of Mathematical and Physical Sciences building. The following list of facilities has been broken down according to the location (or intended location) of the equipment. If you require the use of any equipment located in Aberystwyth or require further information please contact the senior experimental officer: Dr Dave Langstaff (Email: dpl@aber.ac.uk, tel:01970 621 913)

## Materials Research Laboratory

The following equipment is located in the materials physics research laboratory (Mat-Lab). The layout of this laboratory and the locations of the equipment are shown on the preceding diagram. The facilities include:

1. **Spectroscopic Ellipsometry**
    a. Control and data capture computer
    b. Sample chamber temperature control rack

   Sopra GESP5 Variable incidence Spectroscopic Ellipsometer
   Additional measurement capabilities: Spectroscopic reflectivity and transmission measurements, Off-specular scattering
   Sample Chambers: Cryogenic sample chamber for temperatures down to 4K, Optically heated sample chamber for temperatures up to 1000K, LS sample chamber for investigations at the Liquid/Solid interface

2. **Raman Spectrometer**
    a. Control and data capture computer

   Jobin Yvon LabRam HR Raman Spectrometer with confocal microscope and Sperhead for in-situ measurements.
   Lasers: HeNe 632.8 nm and Argon Ion 488 nm
   Sample Chambers: Cryogenic chamber for temperatures down to 4K

3. **Real-time Electron Energy Spectroscopy (REES)**
    a. Services rack – vacuum control and monitoring
    b. Instrumentation rack – spectrometer control electronics
    c. Data capture computer

   Specs PhoiBOS 100 analyzerm, X-ray Photoelectron Spectroscopy – twin anode x-ray gun (Al kα & Mg kα), Ultraviolet Photoelectron Spectroscopy (Specs UVS UV lamp), Low Energy Electron Diffraction, Organic Molecular Beam Deposition, Metal evaporation, In situ I-V measurement.

4. **I-V Measurement suit**
   I-V measurements for semiconductor device characterization

5. **ESCA X-ray Photoelectron Spectroscopy System – AEI ES200**
    a. Measurement instrumentation and data capture computer
    b. X-ray Power Supply
    c. Electron beam heating controllers, prep chamber controllers
    d. Pump controllers

   Old but well characterized XPS system.

6. **ESCALAB Mk2 XPS System**
    a. Service rack – vacuum control and monitoring

b. Instrumentation rack – spectrometer control electronics

Vacuum Generators ESCALAB MK2 XPS system.
Currently being fitted with prototype vacuum polymer electrospray system.

7. **Grinder-Polisher**
   Buehler Ecomet 3 variable speed grinder-polisher with Automet 2 power head.

8. **Carbolite drying oven**

9. **Carbolite 1700 °C furnace**

10. **Carbolite 1500 °C furnace**

11. **Buehler Isomet 1000 precision saw**
    150mm diamond disc cut off saw for preparing ceramic samples.

12. **Specac 15 ton hydraulic press**
    For pressing powder samples into pellets, crushing solids for XRD measurements etc.

13. **Spex Certi Prep 8000D Mixer Mill**
    Ball mill for breaking down samples to nanoparticles and mixing powdered samples.

14. **Elga Labwater Option R7 water purification system**
    Reverse osmosis water purification with UV lamp and 25L reservoir. Produces 7L of 15 MΩ cm water per hour.

15. **Laboratory scales**
    Collage B154 scales. Range up to 150g, resolution $10^{-4}$g.

16. **Ultrasonic Cleaner**
    Decon FS200 frequency sweep ultrasonic cleaner for cleaning samples and equipment.

17. **Belling Drying Oven**

18. **Plasma Cleaner**
    Harrick PDX-3XG Plasma cleaner with Argon gas supply for cleaning and sterilizing samples and equipment.

19. **Turbo vacuum System**
    Scanwel Cube frame turbo vacuum pumping system for electron detector testing and characterization.

20. **X-ray Powder Diffractometer**

a. Control and data capture computer

Brucker D8 Advance powder diffractometer fitted with Vantech Super Speed position sensitive detector.

**21. Portable Vacuum System**

Pfeiffer TPU 330 turbo vacuum system on mobile frame for testing purposes and running small experiments

The following equipment is located in various rooms thorough the department. Much of the equipment is set up for use and some is in temporary storage until it is required.

**22. Ozone Oxidation System**

Ozomax ozone generation, oxidation and destruction system for rapid controlled oxidation of semiconductor materials.

**23. Imaging Ellipsometer**

Experimental prototype imaging ellipsometer for surface characterization. Still under development.

**24. Edwards 15 cm bell jar evaporator**

Edwards speedvac combination pumping unit with 6.E.2. coating unit for evaporating films from a variety of materials.

**25. Mobile Luminescence end station**

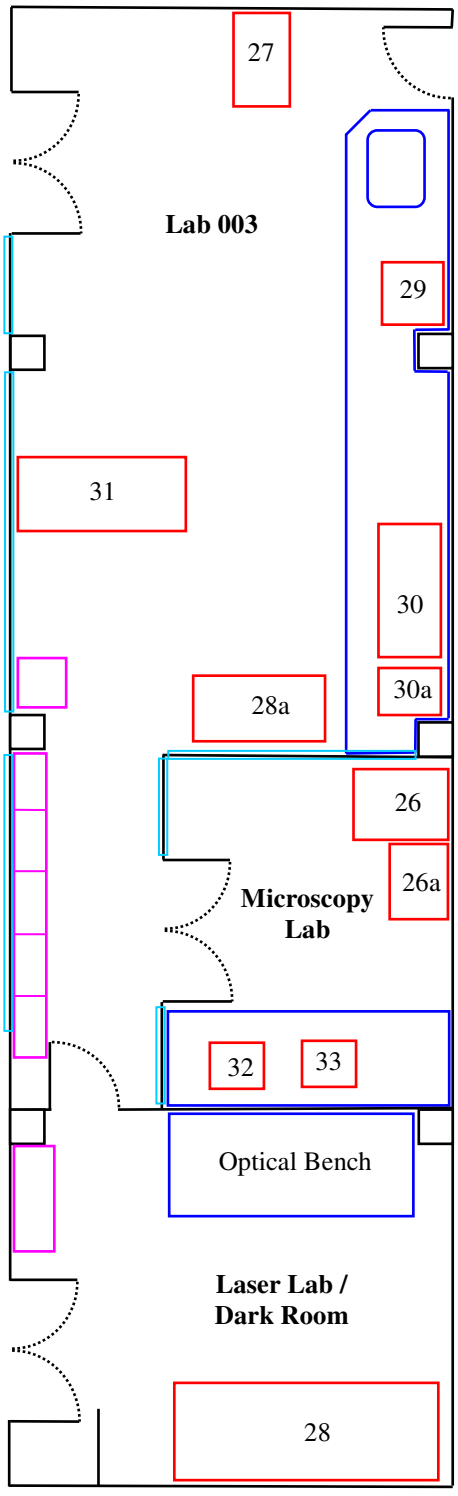
a. Closed loop helium cryostat cooler
b. Data capture and control computer

Luminescence system for use as a synchrotron end station or off line with laser absorption.

**26. 4 Axis Gonioreflectometer**

Measures “Bidirectional Reflectance Distribution Function” BRDF of small samples (min approx 1cm square). White light source, Spectrometer spectral range 300-1150nm, Angular resolution 0.25 deg on each axis, LabVIEW control.

The following facilities are situated in the new extension of the materials research laboratory (room 003) in the basement of the physics building. The lab is equipped with a closed loop water cooling system and includes a microscopy suit and a dark room / laser lab.



**27. Atomic Force Microscope**

a. Control electronics, control and data capture computer

Psia XE100 Advanced Scanning Probe Microscope
Capabilities: Atomic force microscopy, Electric Force Microscopy, Interfacial Force Microscopy, Scanning Tunneling Microscopy. Includes a High precision temperature controlled liquid cell for in vivo imaging.

**28. Edwards 30 cm bell jar evaporator**

For evaporating films from a variety of materials.

**29. Aberystwyth experimental levitating furnace**

a. Control and data capture computer

Spherical samples levitated on a jet of Argon and heated with Synrad Evolution 125W $CO_2$ laser.

**30. Gold Sputter Coater**

Polaron Bio Rad E5200 automatic gold sputter coater.

**31. Hall effect & 4 point probe system**

a. Data capture computer

Signatone 4 point probe for conductivity measurements.
Oxford instrument electromagnet and measurement instrumentation for determining carrier concentrations in semiconductor materials.

**32. Classix (Chemical Luminescence and Structure of Surface via micro Imaging X-ray absorption)**

Luminescence imaging system for use as a synchrotron end station or off line with laser absorption.

**33. Meiji MX9430 Polarizing microscope**

Triocular head, strain free 4X 10X 40X objectives, 10X eyepieces, rotation stage with XY mechanical stage, Transmitted and reflected Koehler 30W illumination. A digital SLR camera and photo eyepiece is available for use with this microscope.

**34. Optical inspection microscopes**

A selection of basic optical microscopes for sample examination and inspection.

## Simulation and Visualization

**35. Modeling and simulation supercomputer**

SGI Altix 3000 supercomputer system for modeling and simulation. 64bit computer running linux operating system.

**36. 3D visualization**
ImmersaDesk 3D visualization system, PC controlled, LINUX based, DUAL 64-bit AMD Athlon platform, visualization software by AVS (Development Suite).

## Mars Laboratory

**37. Simulation mars terrain**
Mars terrain simulation region with Mars soil stimulant-D

**38. Motion capture camera system**
12 Infra Red camera Vicon motion capture and tracking system and software

**39. Mars rover chassis**
RCL ExoMars concept E Mars rover chassis

**40. Panoramic camera system**
UWA ExoMars panoramic camera system for rover guidance and navigation

**41. Theodolite system**
High resolution theodolite surveying system

**42. Computing suit**
Standard computing suit with Envision robot modeling, simulation and visualization software

**43. Laser terrain mapping scanner**
Scans terrain to map surfaces in 3D
Range 25m, Resolution better than 5mm

## Rheology

**44. TA Instruments AR2000 Advanced Rheometer**
Measures viscosity, normal stress difference and dynamic properties of fluids as a function of shear rate and temperature.

**45. TA Instruments AR1000 Rheometer**
Measures viscosity, normal stress difference and dynamic properties of fluids as a function of shear rate and temperature.

**46. TA Instruments CP20 Rheometer**
Measures dynamic fluid properties as a function of frequency

**47. Bohlin Instruments RH10 advanced capillary Rheometer**
Measures shear and extensional viscosities as a function of stress rate and temperature.

**48. High Speed Camera**
Vision Research Phantom V7.3 colour high speed camera. 800 x 600 pixel resolution at 6688 frames per second, up to 190,000 frames per second at 32 _ 32 pixel resolution.

## Robotic Telescopes

IMAPS is equipped with two robotic telescope systems for observations of the night sky and the sea over Cardigan Bay. The telescopes are located on the roof of the physics building and at Frongoch farm just outside the campus (installation of this telescope is not yet complete). Frongoch farm offers a wide unobstructed view of the sky and is an excellent dark sky site outside of Aberystwyth. The telescopes are housed in Homedome Robodomes and fitted with Robofocus units so that they can be controlled remotely and are protected from adverse weather. The telescopes are as follows:

**49. Meade 10" Schmidt Cassegrain telescope situated on physics roof**
Fitted with Watec 902H low light CCD camera. Also has a wide angle CCD cameras piggybacked on telescope.

**50. Celestron CPC 11¼" telescope to be situated on Frongoch farm**
A second remotely controlled telescope system. Installation is not yet complete.

**51. Meade ETX-70AT Robotic Refracting telescope.**
A small and portable refracting automated telescope.

## Workshop Facilities

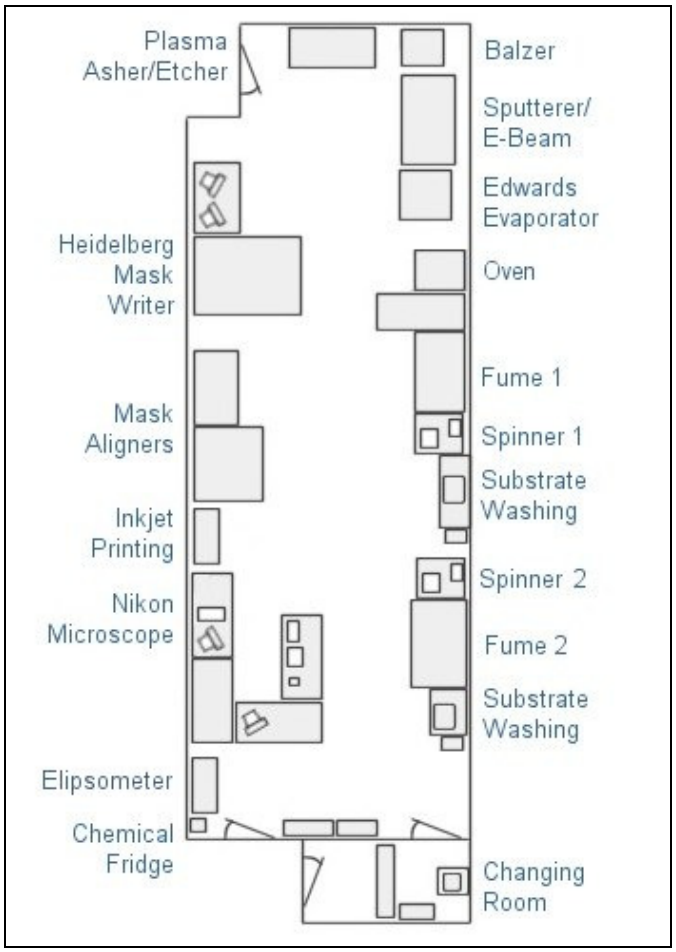
UWA Physics has well equipped electronics and mechanical engineering workshop facilities, providing technical support to the research laboratories. The workshop staff have years of experience in instrumentation and equipment maintenance, manufacture and modification, with capabilities including:

**52. Electronics workshop**
PCB design, etching and assembly
PicAxe microprocessor programming
Programmable logic control
LabView Interfacing

**53. Mechanical Workshop**
Machining (turning, milling etc)
Grinding (surface and spindle)
Welding (TIG, MIG MMA, Brazing, silver soldering)
Precision fitting
Wood machining

# University of Wales, Bangor
# School of Electronics

The School of electronics, located on Dean Street in Bangor, is equipped with equipment and facilities which are predominantly located in the School of Electronics building. If you require the use of any equipment located in the School of electronics or require further information please contact Prof Martin Taylor (Email: d.m.taylor@bangor.ac.uk Tel: 01248 382686). Facilities located in the school of electronics building include:




## Clean Room Facilities

The School of electronics is equipped with an extensive & recently refurbished grade 1000 microfabrication clean room. The layout of this facility is shown in the preceding diagram. Equipment situated in this facility includes:

1. **Heidelberg photomask plotter (0.8 mm resolution)**

2. **Leybold e-beam evaporator/r.f. sputtering unit**

3. **Edwards Evaporator**

4. **Plasma cleaner / asher**

5. **Spin-coaters**

6. **Mask aligner**

7. **Microdrop Inkjet printer**

8. **Optical microscopes**

9. **Variable Angle Spectroscopic Ellipsometer (VASE)**
   Woollam VASE system on vertical goniometer

## UK Laser Micromachining Centre (UK LMC)

School of Electronics are part of the UK Laser Micromachining Centre. If you require the use of LMC facilities then please contact Dr Julian Burt (Email: burt@informatics.bangor.ac.uk ) The LMC equipment located in Dean street consists of:

10. **Exitech M-2000 Femtosecond Laser Micromachining Workstation**

11. **Exitech S-8000 Excimer Laser Micromaching Workstation**

## Surface Analysis Laboratory

12. **Scanning Electron Microscopy (SEM)**
    International Scientific Instruments ISI-40. Image capture software is ISCAN-2000. With Energy-Dispersive X-ray spectroscopy (EDX) facilities

13. **Atomic Force Microscopy (AFM)**
    Digital Instruments Nanoscope IIIa and a TopoMetrix Explorer. The Nanoscope instrument is capable of contact, tapping & tunneling modes, Magnetic Force Microscopy and Kelvin Probe Microscopy. Scan Sizes from 5 nm to 140 um. Liquid cell and a Signal Access Module accessory

14. **Scanning Near Field Optical Microscope (NSOM)**
    Thermomicroscopes Aurora-2

15. **Raman Microscope**

Renishaw System 1000 single grating spectrometer. Lasers available: HeNe 632.8 nm and Argon Ion 514.5 nm.

16. **Fourier Transform InfraRed (FTIR) Spectrometer**
Bomem" Michelson Model MB100 FTIR Spectrometer.
Free Spectral range:
Mid IR region: 0 to 7,900 cm-1
Near IR Region: 0 to 15,800 cm-1
Wavenumber Precision: 0.01cm-1 controlled with internal HeNe laser
Resolution: 4 cm-1 (apodized), fixed

## Design & Modelling

17. **Altera FPGA**

18. **Cadence and PSPICE Circuit modelling**

19. **FEMLAB**
Fluid dynamics, electrostatics, electrodynamics modelling

## Electrical Characterization

20. **Keithley 4200-SCS Semiconductor Characterization system.**
Range 200mV to 200V. With inbuilt computer and monitor, and easy to use software

21. **Keithley Model 237 High Voltage Source/Measure Unit**

22. **Keithley Model 617 Programmable Electrometers.**
200mV to 200V, 2pA to 20mA, 200pC to 20nC, 2kΩ to 200GΩ. (2 off)

23. **Hewlett Packard 4140B pA meter/DC voltage source.**
Range +/- 100V DC, +/- 1 pA.

24. **Solartron 1255 Frequency Response Analyzer and 1296 Dielectric Interface**
Signal amplitude 0-3V rms or 0 to 1V rms. DC Voltage range +/- 40.95V.

25. **Solartron 1250 Frequency Response Analyser.**

26. **Agilent/Hewlett Packard 4284A Precision LCR Meters.**
5mV to 2V rms. DC voltage range +/-40V. (2 off)

27. **Wayne Kerr 6425 Precision Component Analyser.**

28. **HP 54120A Digitising Oscilloscope**

29. **Wiltron Network Analyser**

## Electro-optics Laboratory

If you require the use of any of the high speed optical equipment of spectrum analyzers located at the school of electronics or require further information please contact Prof Paul Spencer (Email: p.spencer@bangor.ac.uk, Tel: 01248 382 686).

30. **Optical Tables (x4)**
    With superdamp active self-levelling isolation system

31. **Lecroy Wavemaster 8600A Oscilloscope**
    6 GHz Bandwidth, 10 Gs/s for four channels, 20 Gs/s for two channels

32. **Tektronik Oscilloscope**
    4 GHz Bandwidth, 10 Gs/s for two channels

33. **Lecroy LC564 A Oscilloscope**
    1 GHz Bandwidth, 4Gs/s for dual channel and 2 Gs/s for quad channels

34. **Burleigh Fabry-Perot Interferometer**
    Operating wavelength is around 850 nm, Frequency Spectral range is 1-1500 GHz, Finesse is more than 150. Input aperture is 20 mm

35. **Agilent 86141B Optical Spectrum Analyser**
    Measuring wavelength from 0.6 μm to 1.75μm, resolution is 0.07 nm.

36. **Anritsu MS9001B1 Optical Spectrum Analyzer**
    Measuring wavelength from 0.6 μm to 1.75μm, resolution is 0.1 nm.

37. **Jobin Yvon TRIAX SERIES 550 Monochromator**
    850 nm and 1550 nm.

38. **Synchroscan Streak Camera**

39. **Stanford Research System SR830 DSP Dual Phase Lock-in Amplifies**

40. **EG&G Applied Research 5207 Lock-in Amplifier**

41. **OPHR CCD Camera**
    Spectral Response: 350nm to 1100 nm

42. **Various Tunable Laser Diode Sources**

43. **Power Meters**

44. **Stanford Research System DS345 30 MHz synthesized Function Generator**

45. **Oxford Instruments cryostat and temperature controller**

46. **Anritsu Spectrum Analyzer MS 710 C**
Measuring Frequency: 10 kHz – 23 GHz

47. **AVTECH AVNN-1-C Pulse Generator**
Frequency Range: 25-250 MHz, 100 ps rise time

## UWB at Optic Technium

In addition to the facilities located in the School of electronics building in Dean Street, the school of electronics has facilities located in the Opto-electronics Technology and Incubation Centre (OpTIC) Technium in St Asaph. These facilities include:

48. **Polymer Labs GPC50 Gel Permeation Chromatography System**
Light Scattering Detector & Software, Integrated GPC System, Viscometer, Degasser, Data Interface, GPC Autosampler

49. **Polymer Labs GPCXT220 Rapid Integrated Gel Permeation Chromatography System**
Bridge Viscometer, Rapid Integrated GPC System, Light Scattering Detector, High Temperature Autosampler, Data Interface

50. **Perkin Elmer Differential Scanning Calorimeter (DSC)**
Differential Scanning Calorimeter, Pyris Advanced Kinetic Suite Software, Pyris DSC Step Scan Software, Intracooler

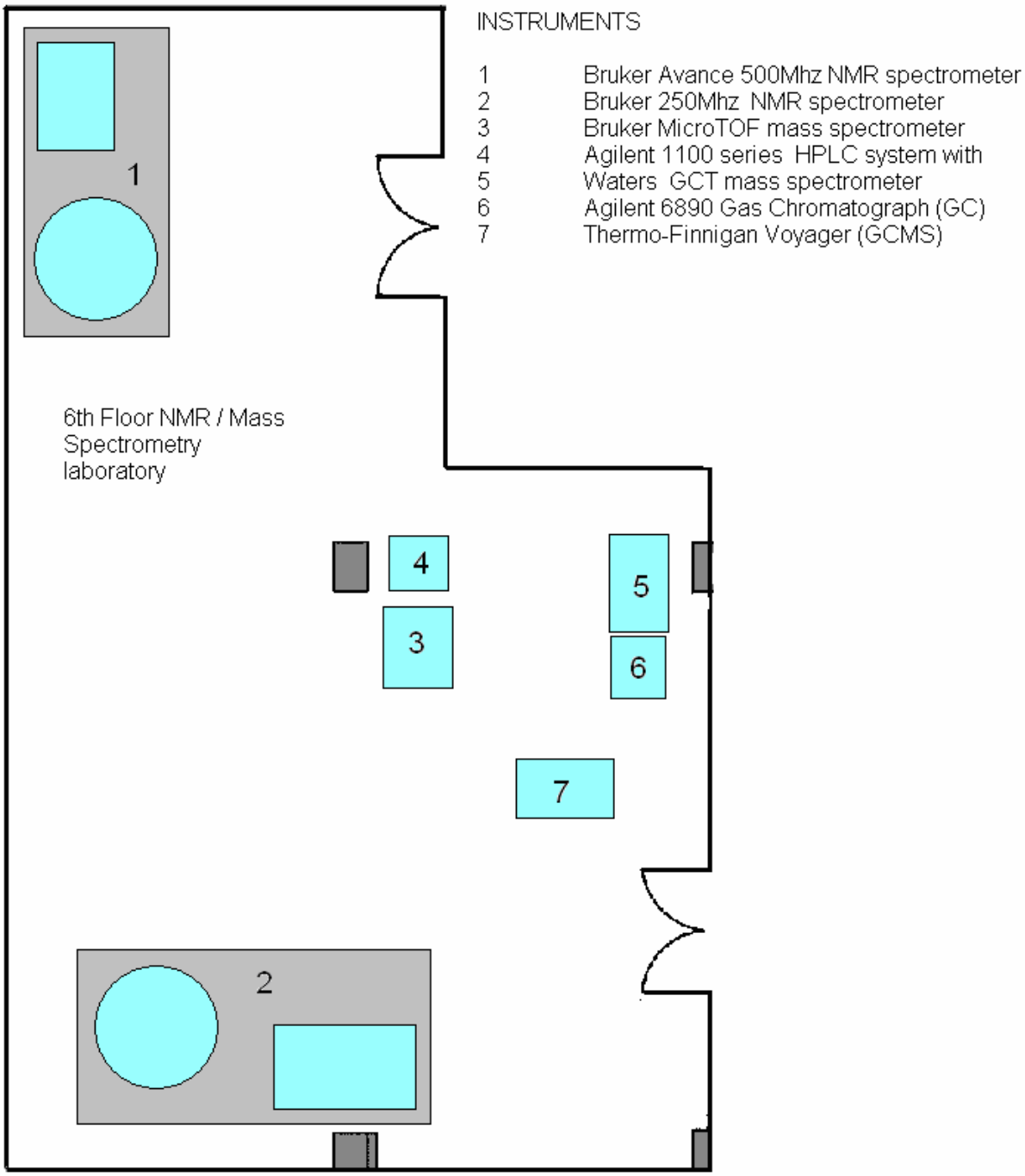
51. **Perkin Elmer Thermogravimetric Analyser (Pyris 1TGA)**

52. **Perkin Elmer Dynamic Mechanical Analyser (DMA)**
Onboard PC, Film Shear Head, 3 Point Flexure Clamp, Exstar Thermal Analysis Software, Shear Head, Compression Head, Transformer Cooling Controller and Dewar

# University of Wales Bangor
# School of Chemistry

The School of Chemistry, located just back from Deiniol Road, has a range of facilities. If you require the use of any equipment located in the School of electronics or require further information please contact Mr Denis Williams (Email: d.j.williams@bangor.ac.uk). Facilities located in the school of chemistry includes:

## Characterisation Facilities



1. **Nuclear Magnetic Resonance (NMR)**
   NMR spectroscopic facilities at both 250MHz and 500MHz. Both these instruments have automated facility, multinuclear probes (up to silver), broadband solid state, variable temperature solid state, multidimensional spectra, inverse detection capability, variable temperature analysis of samples. The 500MHz machine can be connected to other systems such as LC and MS.

2. **Mass Spectrometry (MS)**
   Two research grade time of flight instruments deliver accurate mass measurements (resolution > 5ppm above 300Da). The MicroTOF has electrospray and atmospheric chemical ionisation interfaces and can be linked to an Agilent HPLC system to perform LCMS analysis. The GCT has electron and chemical ionisation sources and is linked to an Agilent 5890 gas chromatograph for GCMS analysis. There are a number of quadrupole GCMS systems within the school for routine analysis. MALDI facilities are available in the school of biological sciences.

3. **Infrared Spectroscopy**
   Standard FTIR instruments including two Bruker IFS 113v

4. **Chromatography**
   Chromatographic capabilities include numerous Gas Chromatography (GC) systems with a range of detectors for the analysis of volatile organic compounds. Analysis can be further enhanced with Mass Spectrometry detection ( GCMS). High performance liquid chromatography is available with a combination of UV, Diode Array, or Mass Spectrometry (LCMS) detection methods.

5. **Elemental Microanalysis**
   Carbon, Hydrogen and Nitrogen elemental analysis facilities

6. **UV / Visible Spectrophotometry**

7. **X-ray powder Diffraction (XRD)**
   XRD is performed on two Phillips instruments located on the second floor of the Alun Roberts Building these are the X-PERT PRO and PW3830

8. **ESCALAB MK2 X-ray Photoelectron Spectroscopy (XPS)**
   Vacuum Generators ESCALAB MK2 XPS system. located on the second floor of the Alun Roberts building. There are Grazing Incidence Reflectometry (GXR) capabilities for thin film measurements.

9. **Thermogravimetric analysis**

10. **Differential Scanning Calorimetry (DSC)**

11. **Veeko Instruments Atomic Force Microscope (AFM)**

12. **Veeko Instruments Scanning Tunnelling Microscope (STM)**

13. **Surface Plasmon Resonance (SPR)**

14. **Thin film electrical characterization**

15. **Optical Microscopy**

16. **Electrochemical Apparatus**

17. **Laser Beam Induced Current Mapping**

18. **Reflectometers**
    (Single and Triple wavelength laser systems)

## Film Deposition facilities

19. **Edwards coating units**

20. **Langmuir-Blodgett troughs:**
    With combined visible spectrometer and quartz crystal microbalance

21. **Molecular self-assembly:**
    With simultaneous molecular area studies

22. **Edwards coating Units (x2)**

23. **Spin Coating.**

## Biological and Life sciences facilities.

24. **Bioforce Nanosciences nano arrayer**
    A molecular printing system enabling the delivery of ultra micro and Nanoscale fluids containing biomolecules and or other materials to defined locations on surfaces with ultra micro and nano spatial resolution.

25. There are two biological containment laboratories located on the second floor (category 1 and category 2) fully equipped with centrifuges, incubators, autoclaves and other equipment.

## Molecular modeling and computational chemistry.

**26.** A large part of the 3rd floor is dedicated to a visualization suite that can be used to project images of molecules and many other objects in three dimensions. The suite is linked to powerfull computing hardware and software which can be used to calculate the structure energies and properties of complex molecules.

## Workshop facilities.

**27.** **Electronics Workshop Facilities**
Technical experience with servicing equipment and production of custom specialist equipment.

**28.** **Mechanical Workshop Facilities**
General mechanical engineering facilities and glass blowing expertise