Introduction to microfabrication and material characterisation facility at the School of Engineering

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CRL1

CRL4

The Emerging Technology and Materials (ETM) group holds two microfabrication laboratories of class 100 - 10000 with total clean area of 200 m^2

CRL4: Class 1,000 (100 local areas)

CRL1: Class 10,000 (100 local areas)

SoE cleanroom fabrication facility

1. Wet chemical processing	1. Two chemical processing workstations CRL1, CRL4
2. Photolithography	2. Karl Suss MJB-3 mask aligner CRL4 3. EMS 6000 spin coater CRL4
3. Atomic layer deposition	4. Picosun R200 AL tool CRL1 5. Oxford Instruments FlexAL ALD tool (clustered with OI Plasmalab magnetron sputter) CRL1
4. Thin film deposition	6. Edwards 306 thermal evaporator CRL4 7. Edwards 306 e-beam evaporator CRL4 8. Two Kurt Lesker PVD 75 deposition systems CRL4 9. OI Plasmalab system 400 DC & RF magnetron sputter (clustered with the OI ALD machine) CRL1
5. Thermal processing	10. JIPELEC SiC thermal processing furnace CRL4 11. Edwards 306 with TECTRA ceramic resistive heater CRL4 12. Three resistive heating oxidation furnaces CRL4 13. JetFirst 200 bench top RTP processor CRL1
6. Plasma processing	14. TEGAL microwave asher CRL4 15. Plasma-Therm 790 series RIE machine CRL4
7. Packaging and insulation	16. tpt HB16 ultrasonic wire bonder CRL4 17. FINEPLACER® lambda Sub-Micron Bonding System CRL1 18. PDS2010 parylene coater CRL1 19. Dymax BlueWave 75 ultra-violet curing lamp CRL1
8. Process control and characterisation	20. Two optical microscopes CRL4 21. KSV Instruments CAM-100 contact angle meter CRL4 22. Probe station with Tektronix 577 curve tracer CRL4 23. Filmetrics F40 interferometer CRL4 24. Tencor P-1 long scan profiler CRL4 25. Bruker AXS D8 X-ray diffractometer CRL1 26. Horiba Raman microscope combined with Park XE AFM

1. Wet chemical processing

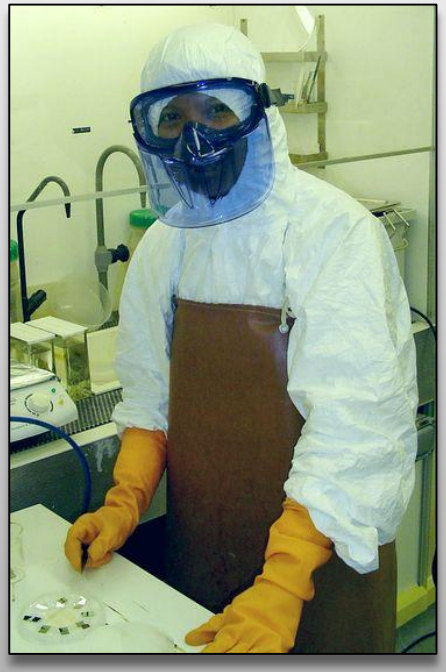
Both SEEE cleanrooms (CRL4 and CRL1) have a class 100 vertical laminar flow work station with air extraction for wet chemical processing (wet bench). They are equipped with

Ultrasonic baths

Chemically resistant hot plates

Nitrogen jets

Sources of DI and ultrapure water

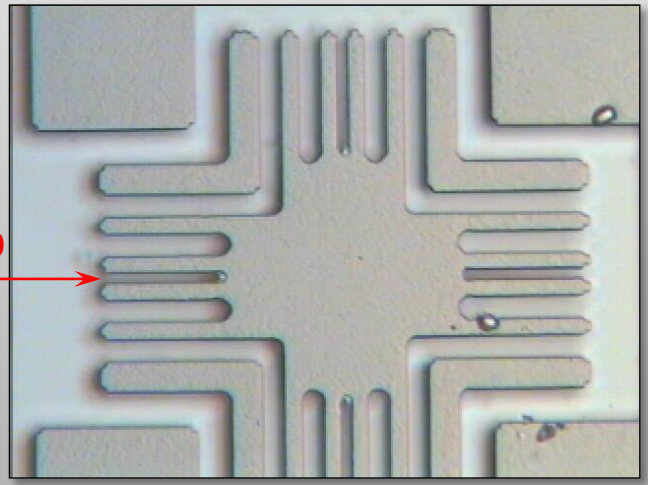


2. Photolithography

1. Karl Suss MJB-3 Mask Aligner
2. EMS 6000 Spin Coater
3. Programmable hot plate and ovens

Contact lithography with maximum resolution ~ 1 um

Wafer size from 5x5 mm to Ø75 mm



Patterned 100 nm thick Ni on SiO_2/4H-SiC substrate

3. Atomic layer deposition

Picosun R200 AL high temperature atomic layer deposition tool. Maximum temperature of substrate – 600°C. Can be used for high temperature, low vapour pressure precursors.

Precursors available:

Trimethylaluminium,	$Al(CH_3)_3$

Reactive gases: H_2O

Oxford Instruments FlexAL ALD integrated with sputter deposition tool. Multi-layered, functional thin films.

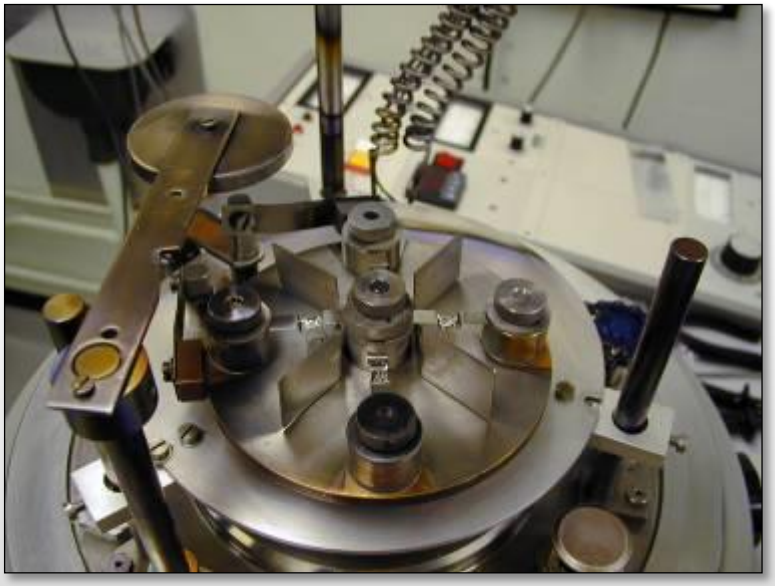
Precursors available:

Trimethylaluminium,	$Al(CH_3)_3$
Ti ISO,	$TiO_4C_{12}H_{28}$
Hf EMA,	$[(CH_3)(C_2H_5)N]_4Hf$
V OISO,	$OV(OCH(CH_3)_2)_3$
Sr absolute (not installed),	Bis(tri-tert-Butylcyclopentadienyl) Strontium

Reactive gases: H_2O, NH_3

4. Thin film deposition

Thermal evaporator



e-Beam evaporator

Quartz crystal sensor to monitor deposition rate and thickness.

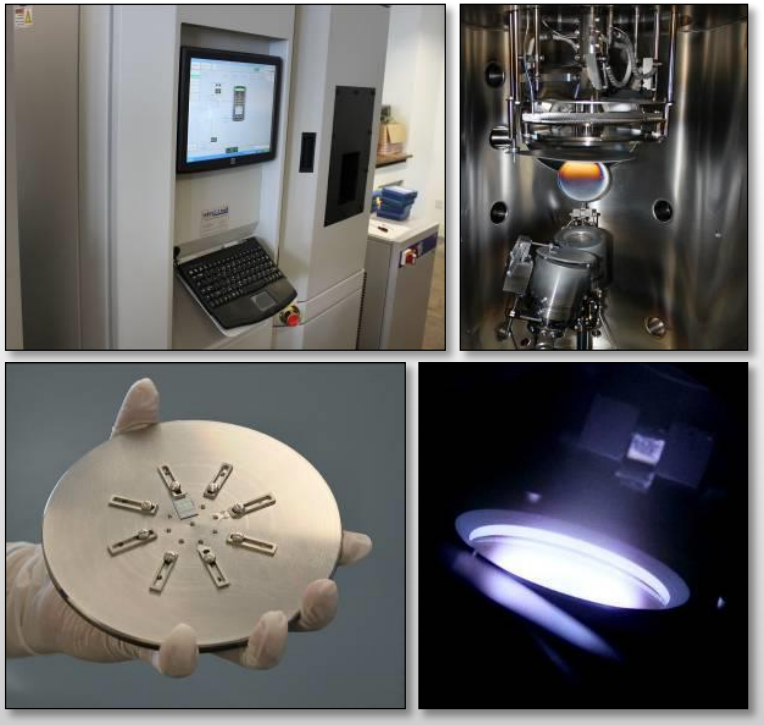
Up to 4 different metals in a single deposition run

Maximum wafer diameter 4 inch

High vacuum chamber (< 10^{-6} mbar) equipped with diffusion pumps cooled by LN

e-Beam evaporator allows deposition of wide range of metals including refractory metals as Tungsten and Molybdenum

Magnetron sputtering:



Two K. Lesker PVD 75 vacuum deposition systems

Each sputter deposition system contains 2 targets for magnetron sputtering with:
2 DC power sources in one system and
1 DC and 1 RF/DC power sources in another system.

Substrate temperature: up to 300ºC
Sputtering environment: N_2/Ar/O_2
Target dimensions: 2” dia and 1/4” or 1/8” thick.
Wafer holder diameter - 6“

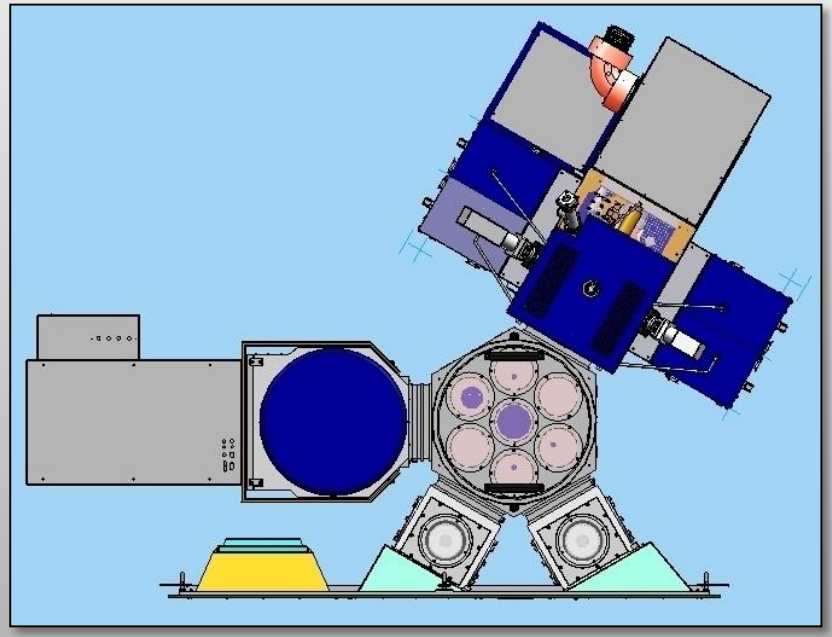
Sputter target materials can be virtually any metal and dielectric material.
Currently we have the following targets in stock:

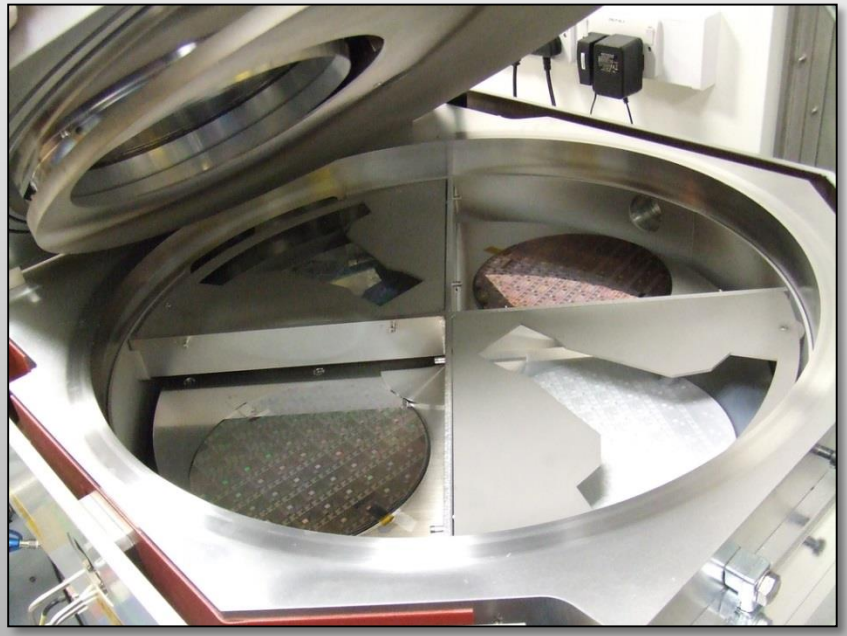
Al; Cr; Cu; Hf; Mo; Ni; Pd; Si, Sn; Ta; Ti; W; Zn; Zr; NiCr; W/Ti(80/20 wt);

Al_2O_3; HfO_2; Si_3N_4; SiO_2; TiO_2

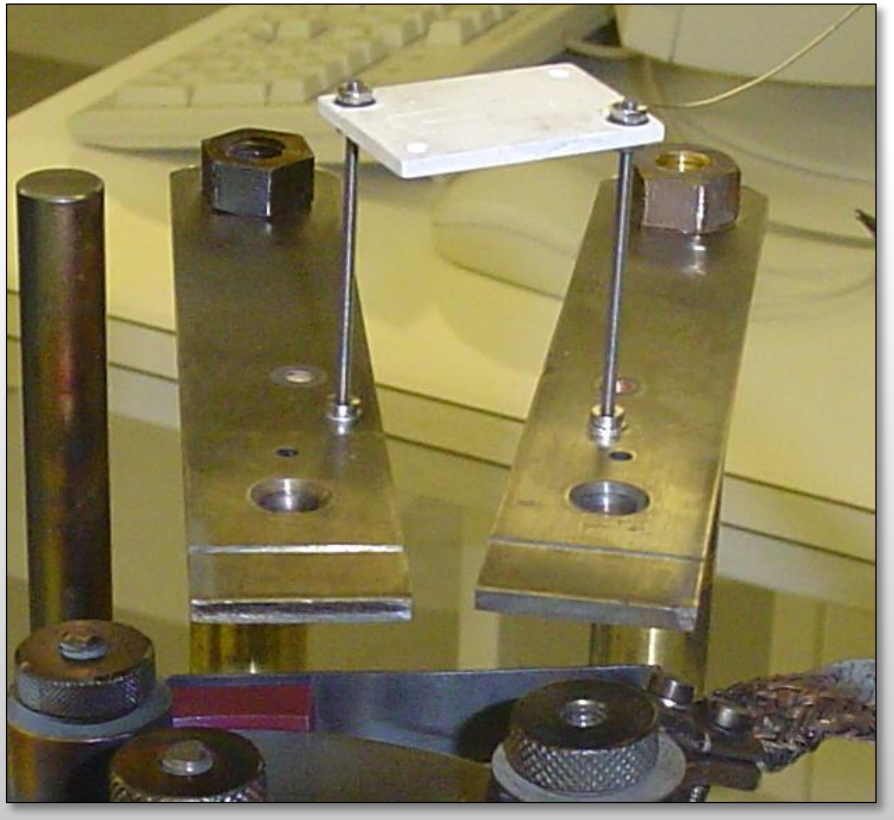
Magnetron sputtering:

Oxford Instruments Plasmalab System 400 DC & RF magnetron sputter clustered with FlexAL ALD tool.
The machine is equipped with 4 inch RF and two 8 inch DC magnetrons for metals and dielectrics sputtering (target thickness: 1/4” or 1/8”).
Sputtering environment: N_2/Ar/O_2
Loading capacitance – 4 wafers of 6“ diameter.
Targets available: Si_3N_4, STO, BTO, BSTO, NiO, CuAlO, SiO_2, Al, Ti, W





5. Thermal processing



- Edwards 306 with TECTRA ceramic resistive heater
- Maximum sample size 20 mm
- Maximum temperature 1040 ºC
- Annealing in high vacuum (~ 10^{-6} mbar)

Annealing graphene on sapphire substrates in high vacuum at 920 ºC

JIPELEC SiC rapid thermal processing furnace

This machine with induction heating allows annealing at temperatures up to 2000 ºC in argon, nitrogen and high vacuum.

It is specified for SiC post-implantation annealing and graphene growth.

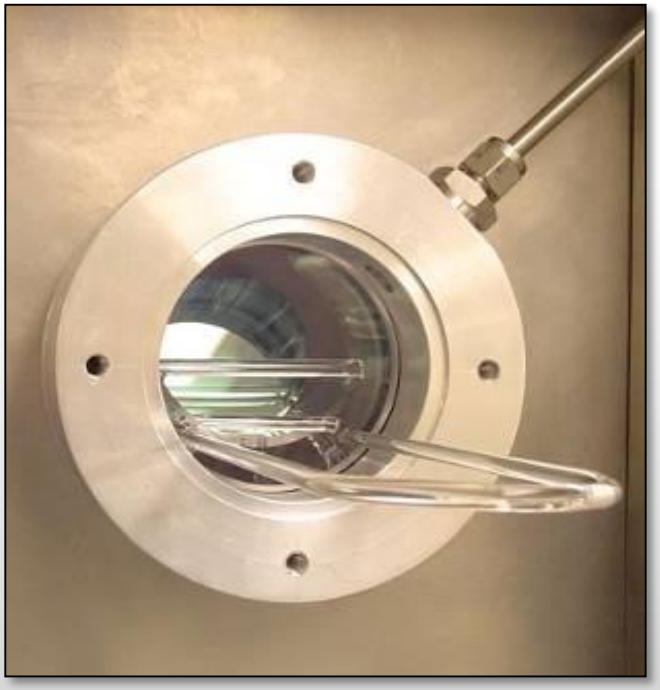
Maximum wafer size is 35 mm diameter.

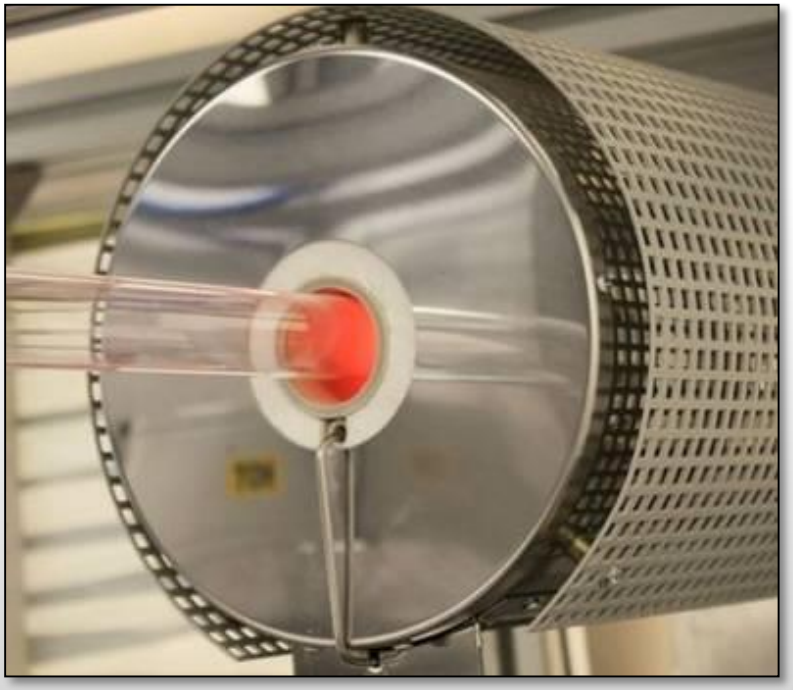
JetFirst 200 bench top RTP processor wafer heating by infrared lamps.

Rapid thermal processing at temperatures up to 1300 ºC in high vacuum, oxygen, nitrogen and forming gas.

Maximum wafer size 200 mm diameter.

Thermal oxidation





3 open flow furnaces with resistive heating and maximum internal diameter 66 mm.

Thermal treatment at temperatures up to 1200 ºC in nitrous oxide, dry oxygen and nitrogen.
Silicon and silicon carbide oxidation, silicon oxide nitridation, polyimide curing, etc.

Plasma-Therm 790 series RIE machine - parallel plate (capacitor type) plasma system.

High vacuum, controlled RF power (up to 500 W), electrode temperature, gases flow and chamber pressure.

Maximum wafer diameter - 8 inch

RIE of silicon, silicon carbide, silicon dioxide, poly-silicon, etc. using SF_6 , CHF_3 , O_2, Ar, N_2 gases and their mixtures

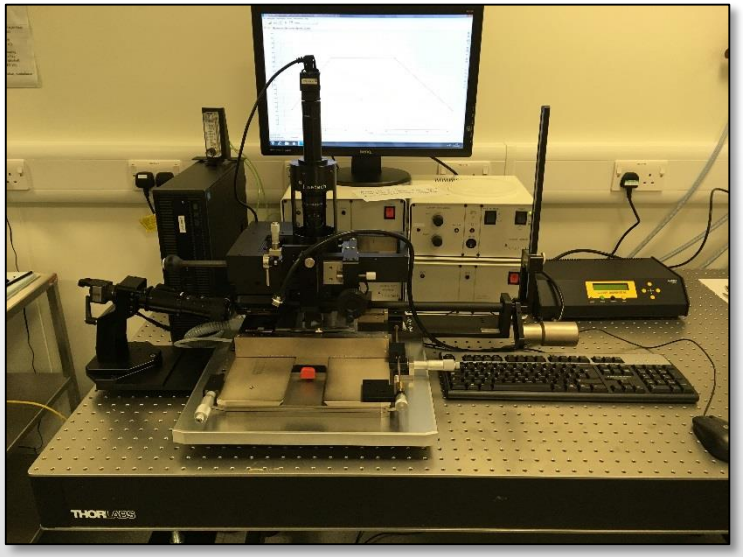
Tegal / March PLASMOD 100 W Tabletop Plasma Reactor

The Actual Chamber Size is about 6" deep and 4.5" internal diameter (3 inch maximum wafer diameter). 0-100 W RF Power at 13.56 MHz.

Low vacuum, residual gases.

Photoresist descumming, sample cleaning, surface functionalisation.

Finetech Lambda FINEPLACER® Sub-Micron Bonding System

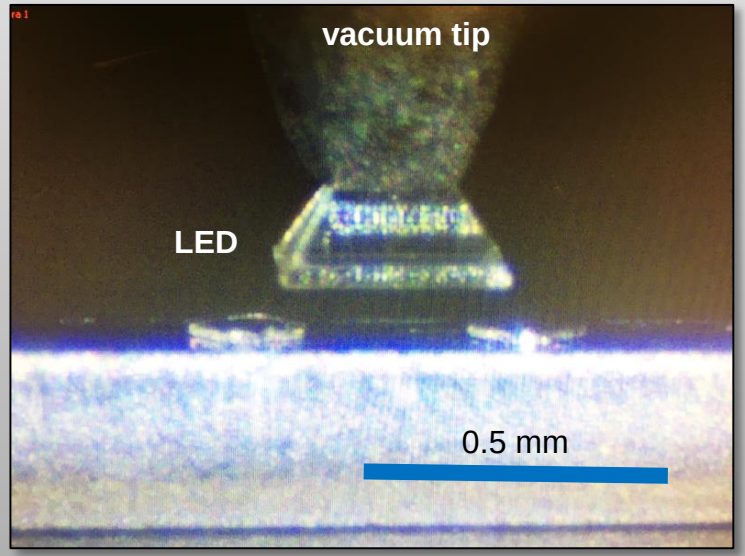


Capable of positioning fine pitch devices (flip chips, MEMS, micro sensors, bare chips, SMD, etc) as small as 30 μm x 30 μm.

Submicron placement accuracy.

Closed loop force control.

Heating temperature up to 400 °C



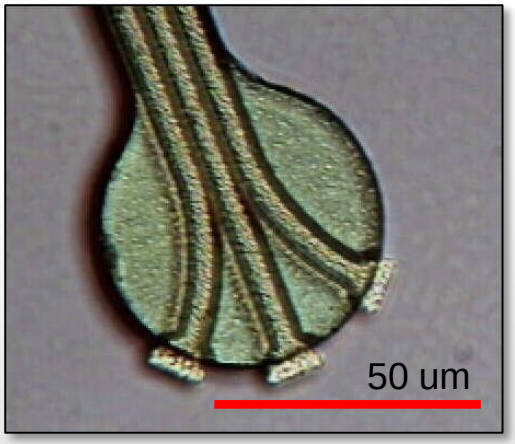
Bonding of a micro-LED onto a 300 μm wide silicon probe using the Fineplacer. Bonding temperature ~ 300 °C applied by the vacuum tip and chuck.

tpt HB16 ultrasonic wire bonder
with vertical feed of wire or ribbon, manual X-Y control of the work piece, and motorised control of the Z and Y axis for bond tool.

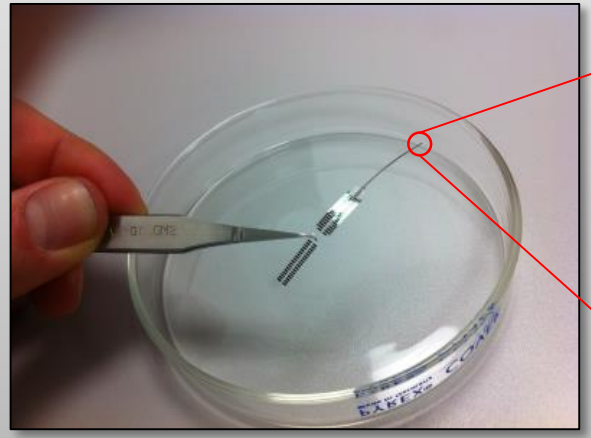
- Wedge, ball, bump and ribbon bonding capable.
- TFT touch screen control.
- Programmable loop profile for wire bond.
- 17 µm to 75 µm wire compatible.

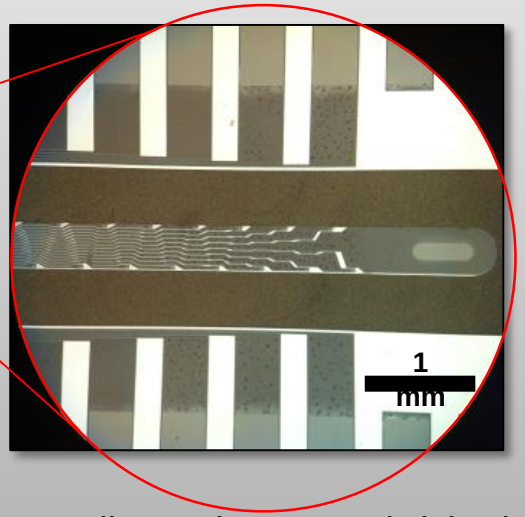
PDS2010 parylene coater

Portable parylene vapour deposition system provides clear and uniform polymer coating with high dielectric and mechanical strength providing an extremely effective chemical and moisture barrier,



Intracortical electrode with 3 insulated Ti/W leads





Flexible micro-electrode (metal recording sites sandwiched between two 10 μm thick parylene-C layers) before and after its release from the carrier silicon wafer.

Dymax BlueWave 75 ultra-violet curing lamp

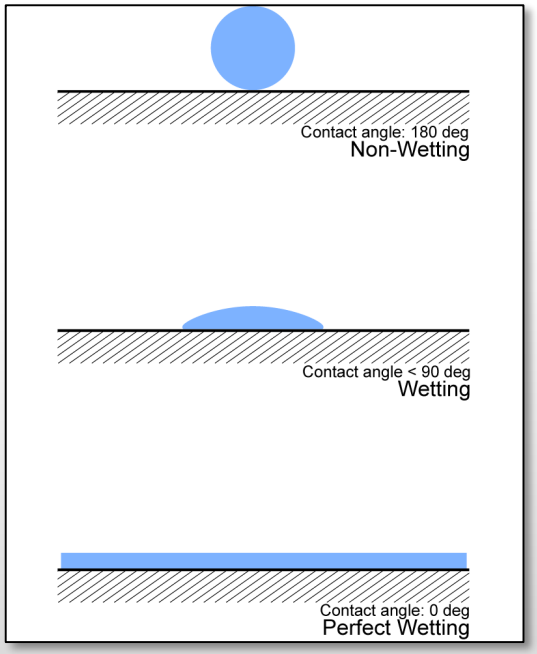
High intensity UV source for curing applications (up to 9 W/cm^2)

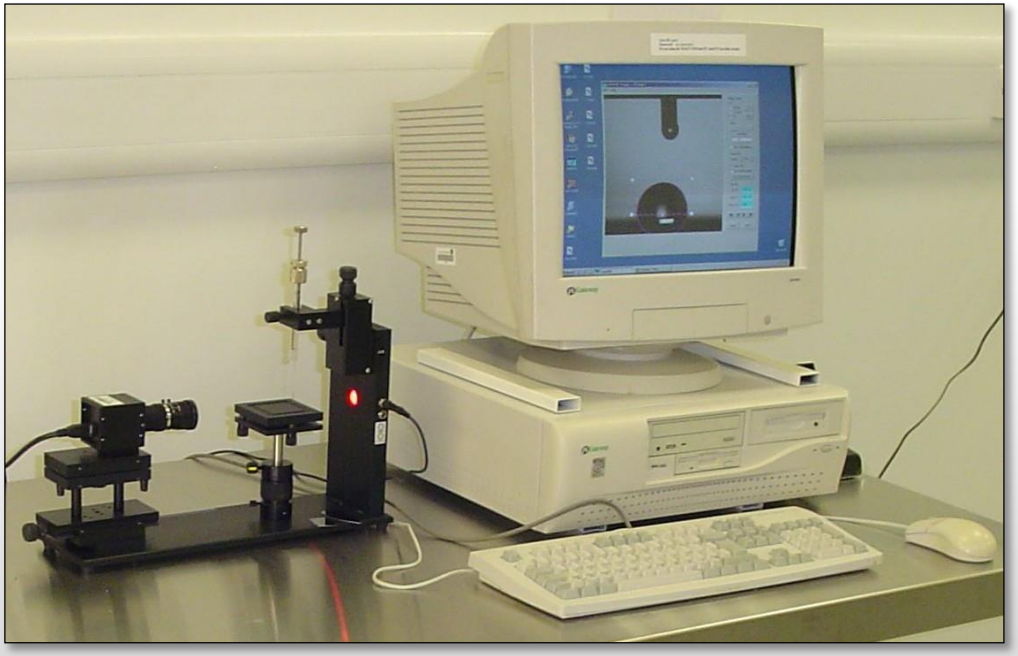
Programmable shutter and timer or footswitch

Fiber light guide

Olympus BX41M allows visual examination of samples at maximum magnification x500 in reflected non-polarized light. This microscope has UV transparent optics and UV light source to observe specimen fluorescence.

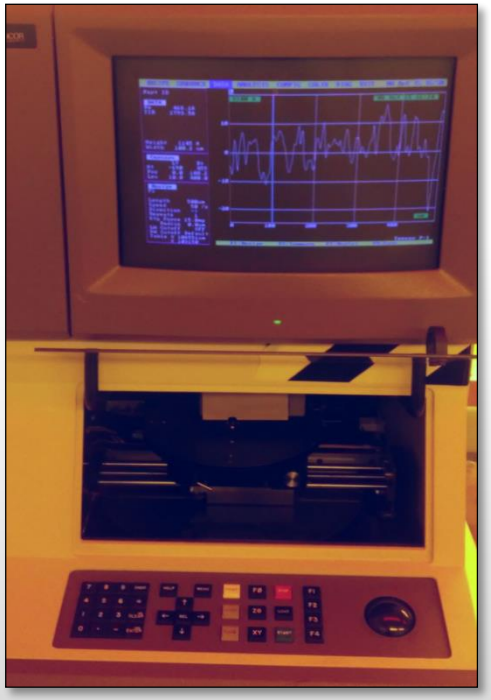
Leitz Wetzlar Optical Microscope allows visual examination of samples at maximum magnification x1000 in reflected or transmitted non-polarized and polarized light.



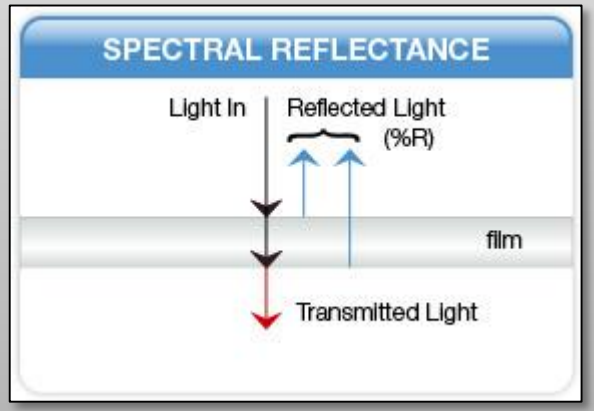


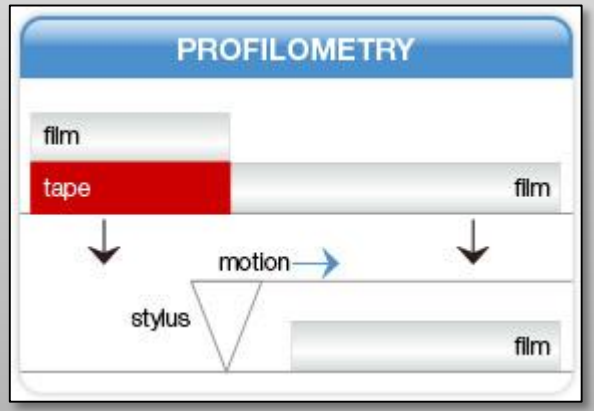
KSV Instruments CAM-100 contact angle meter - a compact CCD camera based instrument for measuring contact angles (CA) of liquids on solids and Free Surface Energy of solids.

Filmetrics F40 Thin Film Thickness Measurement System

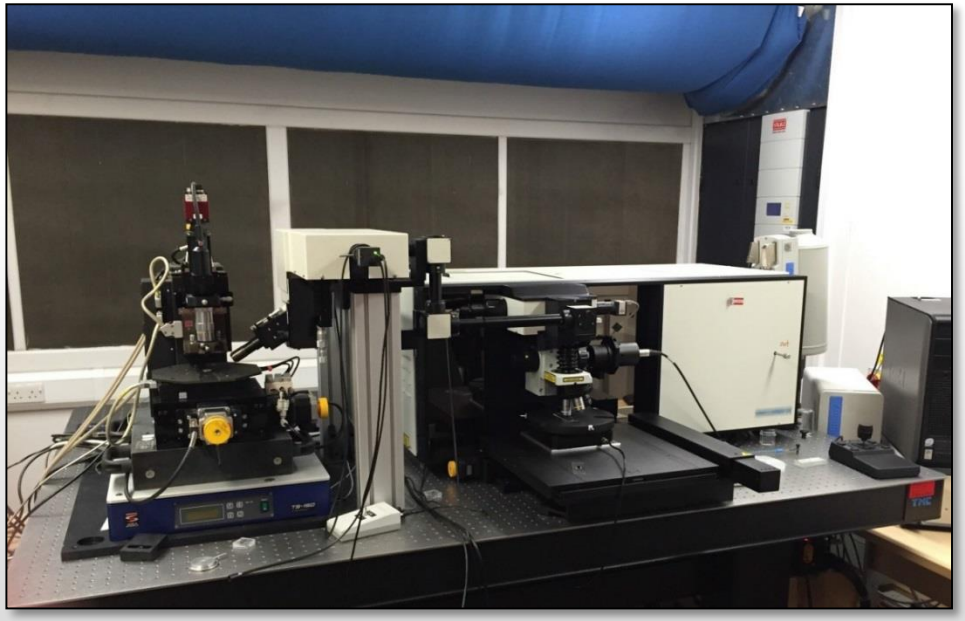


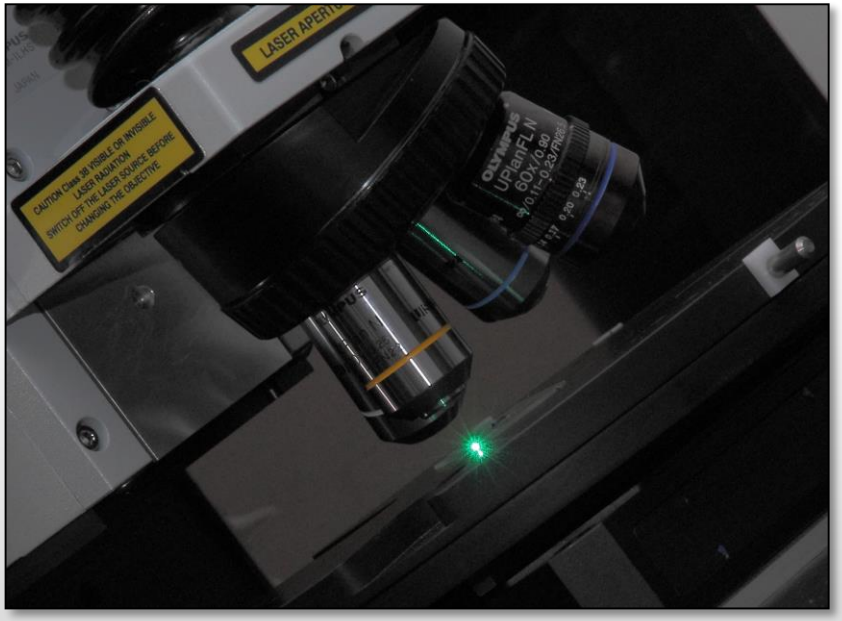
Tencor P-1 long scan profiler



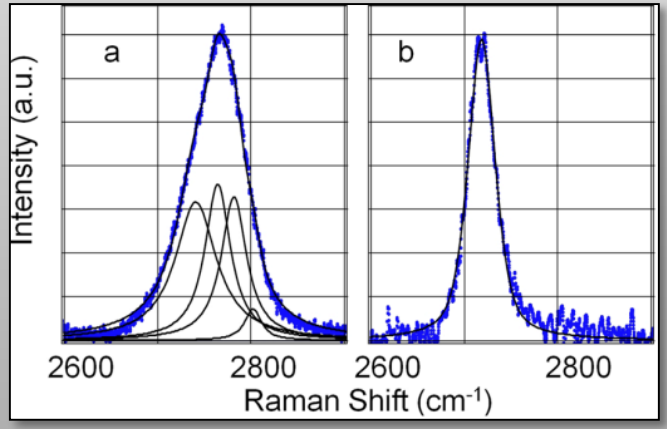


Horiba Raman microscope combined with Park XE AFM





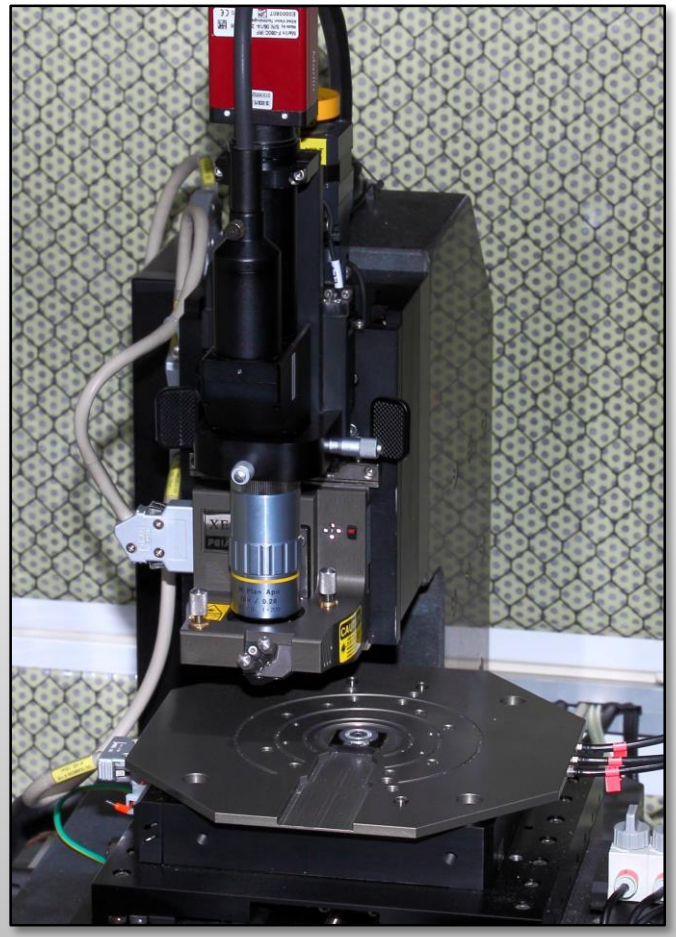
High spectral resolution Horiba Raman microscope combined with Park XE AFM.
Tuneable Argon laser source (514 nm and 457 nm).



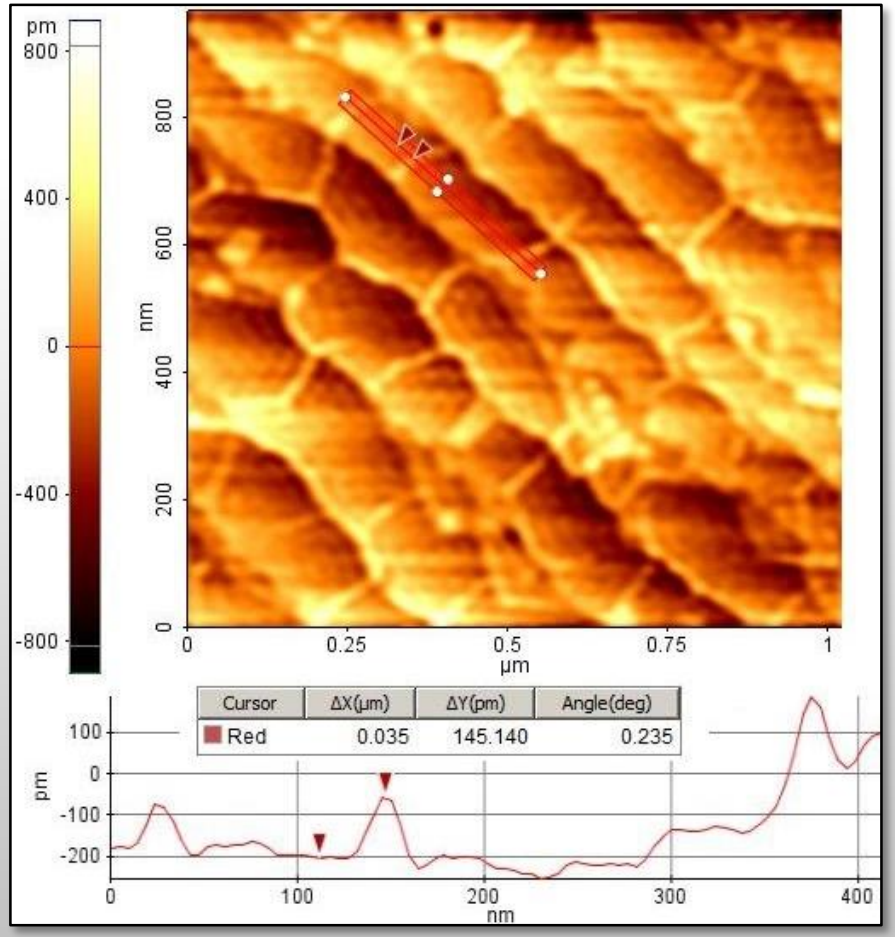
2D bands in Raman spectra of

(a) bilayer EG grown at 1775 ºC for 60 minutes in high vacuum (P_{2D}= 2767 cm^{-1}; $FWHM_{2D}$=68 cm^{-1}); and

(b) monolayer EG grown at 1800 ºC for 4 minutes in high vacuum (P_{2D}=2724 cm^{-1}; $FWHM_{2D}$=32 cm^{-1}).

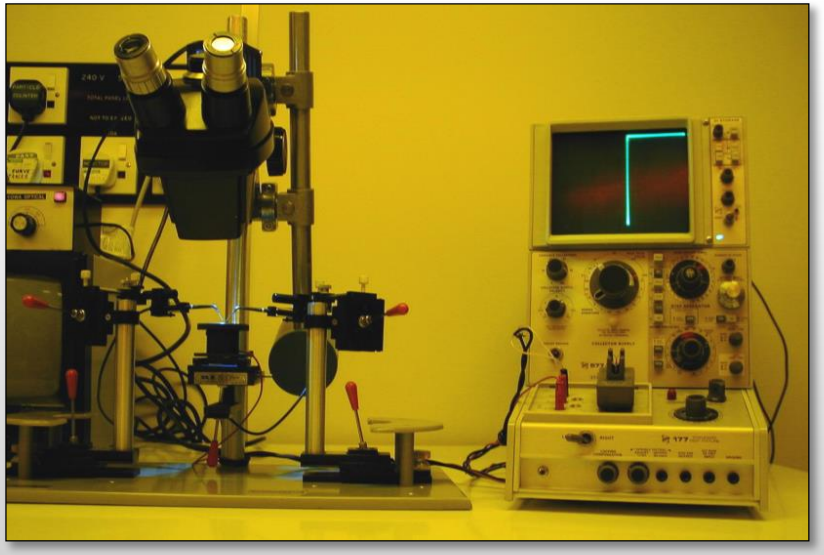


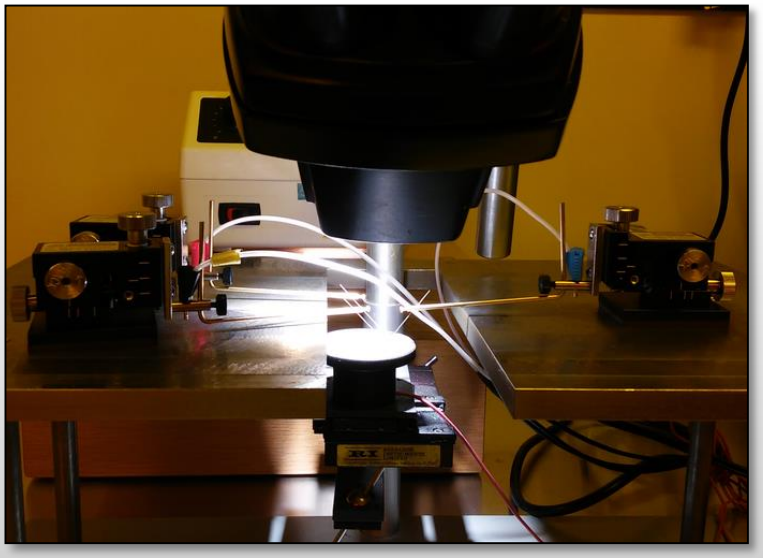
Park XE AFM



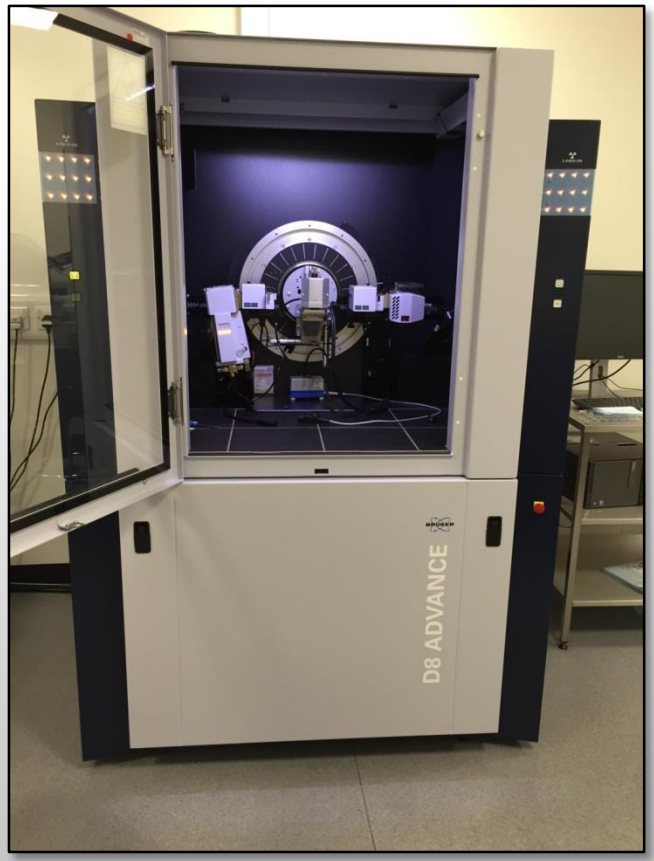
1×1 µm AFM scan of epitaxial graphene grown on the Si-face of 4H-SiC. The bottom panel shows a line section across the graphene wrinkles.

Probe station with Tektronix 577 curve tracer





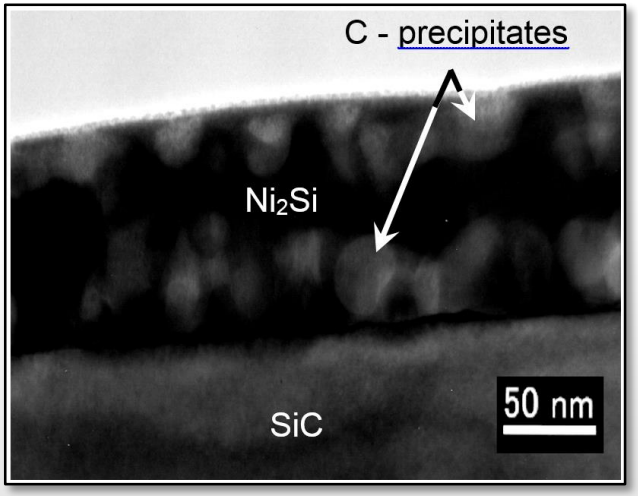
Bruker AXS D8 X-ray diffractometer



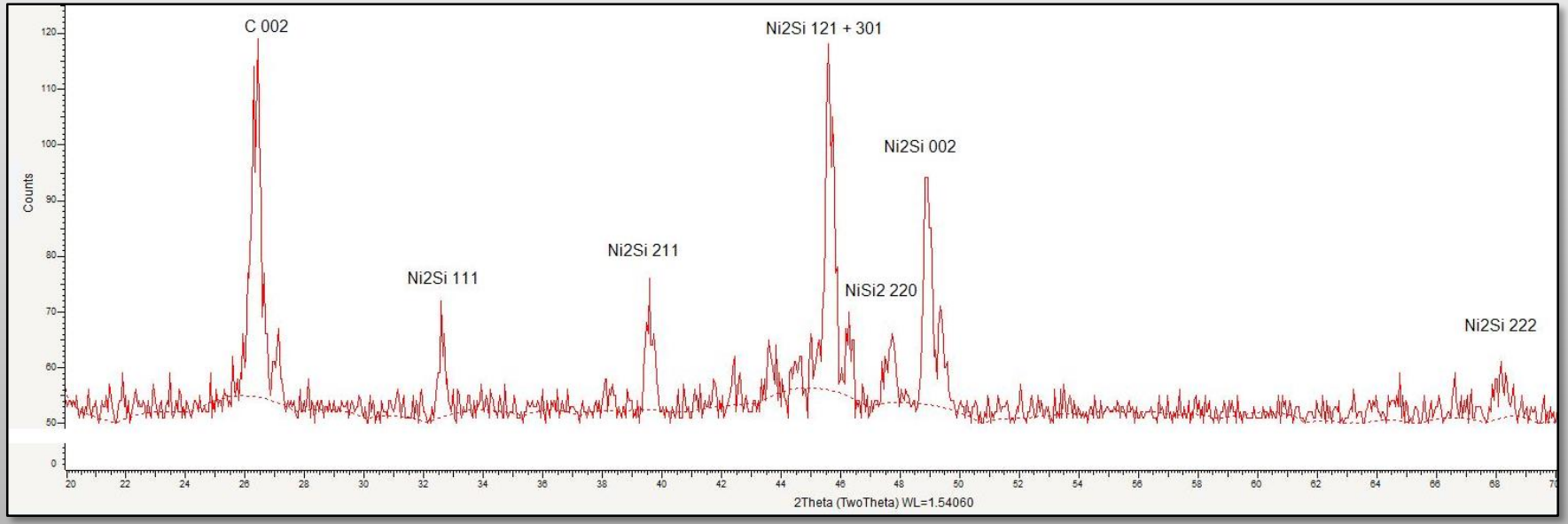
Equipped with Cu Kα X-ray source.

Primary and diffracted beam optics includes Göbel mirror and Soller slit.

Bruker AXS D8 X-ray diffractometer

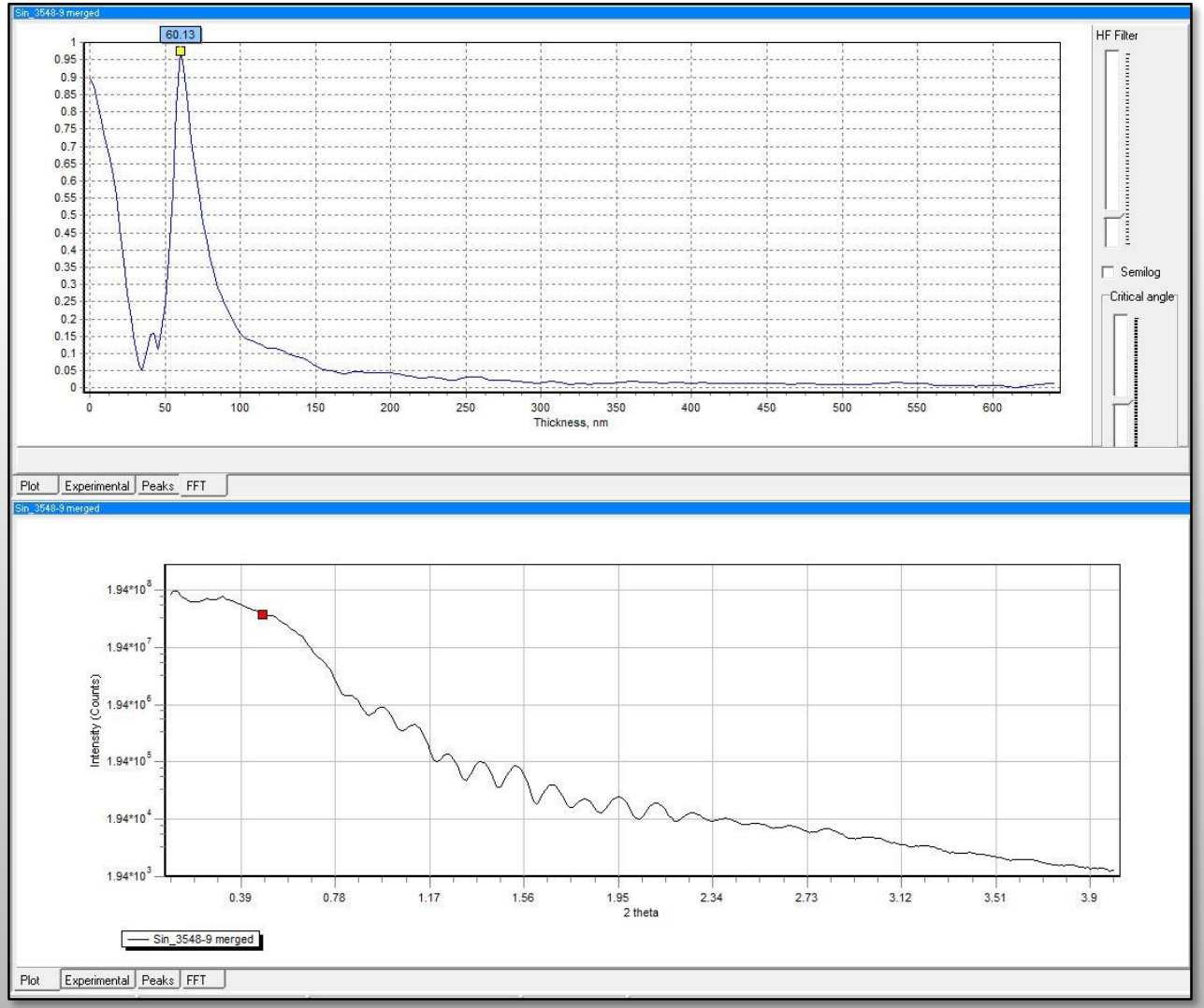


Thin film phase identification by glancing incidence XRD



(Ni(150 nm) on 4H-SiC substrate after annealing at 1040 °C for 800 seconds

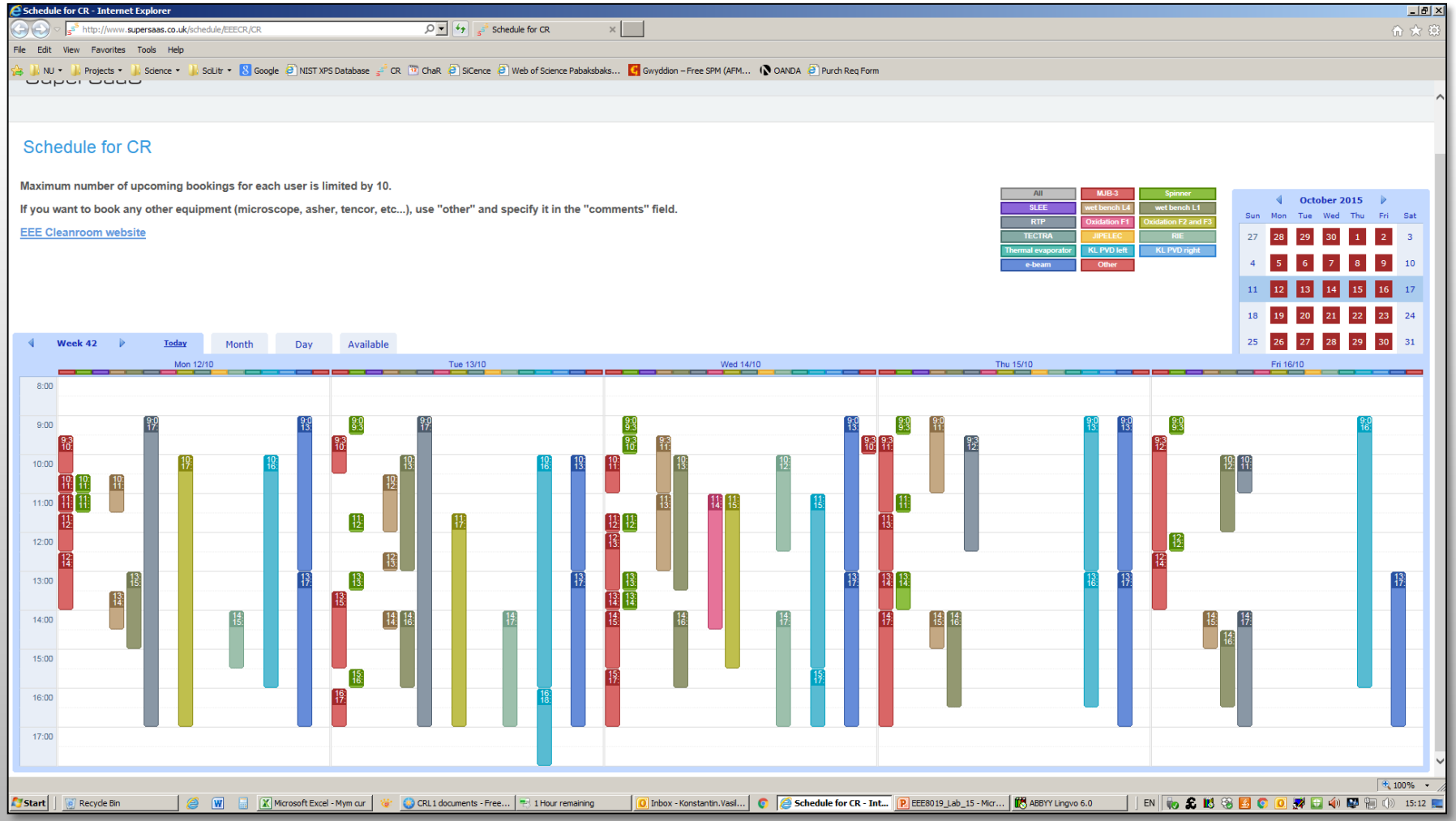
Bruker AXS D8 X-ray diffractometer



XRR from 60 nm thick PECVD Si_3N_4 film on Si substrate

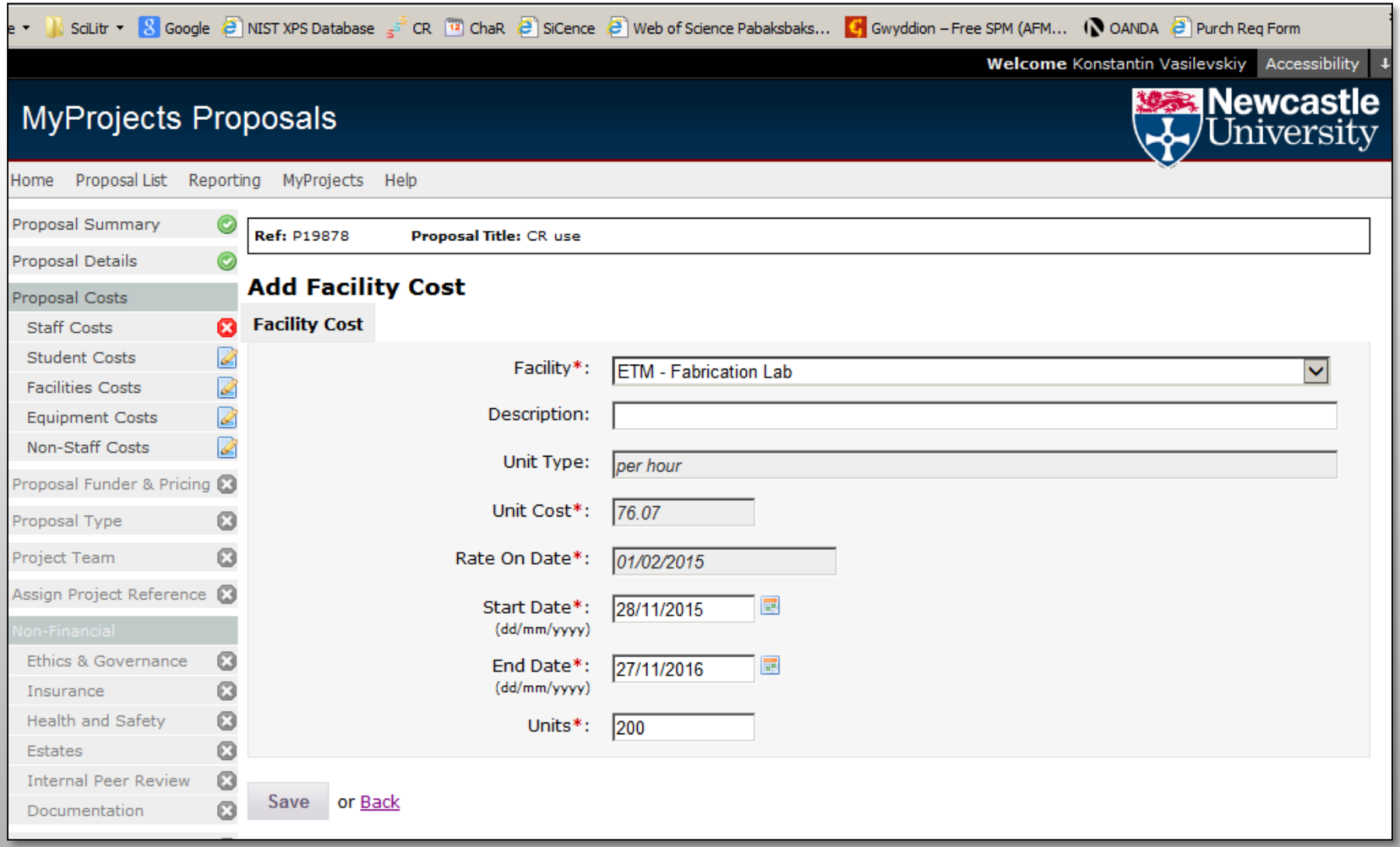
SEEE fabrication facility online booking system

Facility booking is available for all registered cleanroom users from anywhere through the on-line service at http://www.supersaas.co.uk/schedule/EEECR/CR



Control of cleanroom usage and finances

Cleanroom expenses are accounted in a separate cost centre. The per hour cost of cleanroom use is included in the University on-line proposal generation system.



Thank you!

Further information:

1. Somewhere in the school website

2. Internally accessible shared drive
\\eecestore\CleanRoomDocuments

3. Contact the cleanroom manager
konstantin.vasilevskiy@newcastle.ac.uk