



Midterm Review Dublin 2002



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Department of Physics



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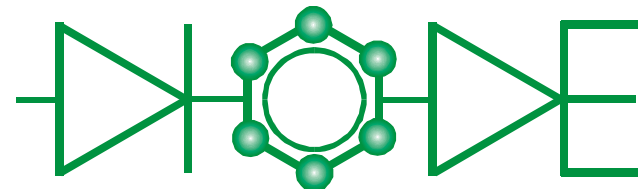


Group members:

Grégory Cabailh
Justin Wells
Simon O'Brien
Kevin Thompson
Pr. Iggy McGovern



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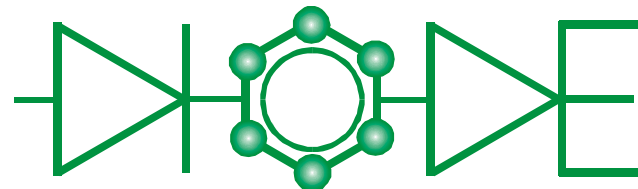


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- Nationality: French
- 1995-2000: Degree in Science of Materials, Université Paul Sabatier, Toulouse, France.
- Joined the DIODE network as a postgraduate student in August 2000.
- PhD subject: GaAs (001) surface preparation for organic thin film growth and characterisation of the organic/inorganic interface. Organic molecules used: PTCDA, MgPc, PbPc, CuPc.



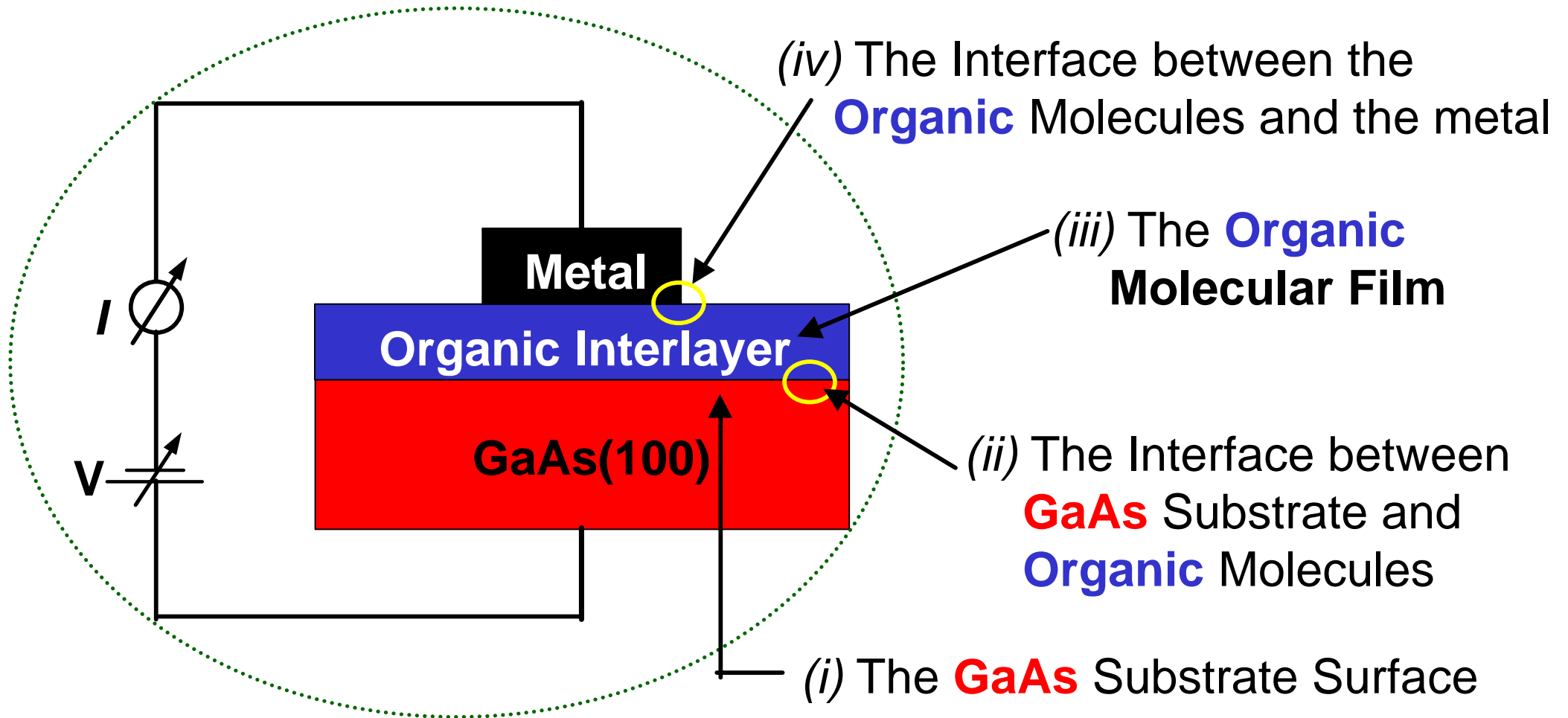
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The Project

(v) The Overall Device Performance





Surface characterisation methods

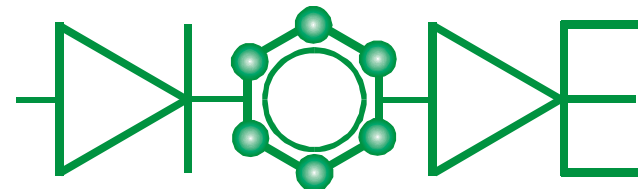


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- Auger Electron Spectroscopy (AES)
- Low Energy Electron Diffraction (LEED)
- Synchrotron radiation measurements (SXPS, NEXAFS)



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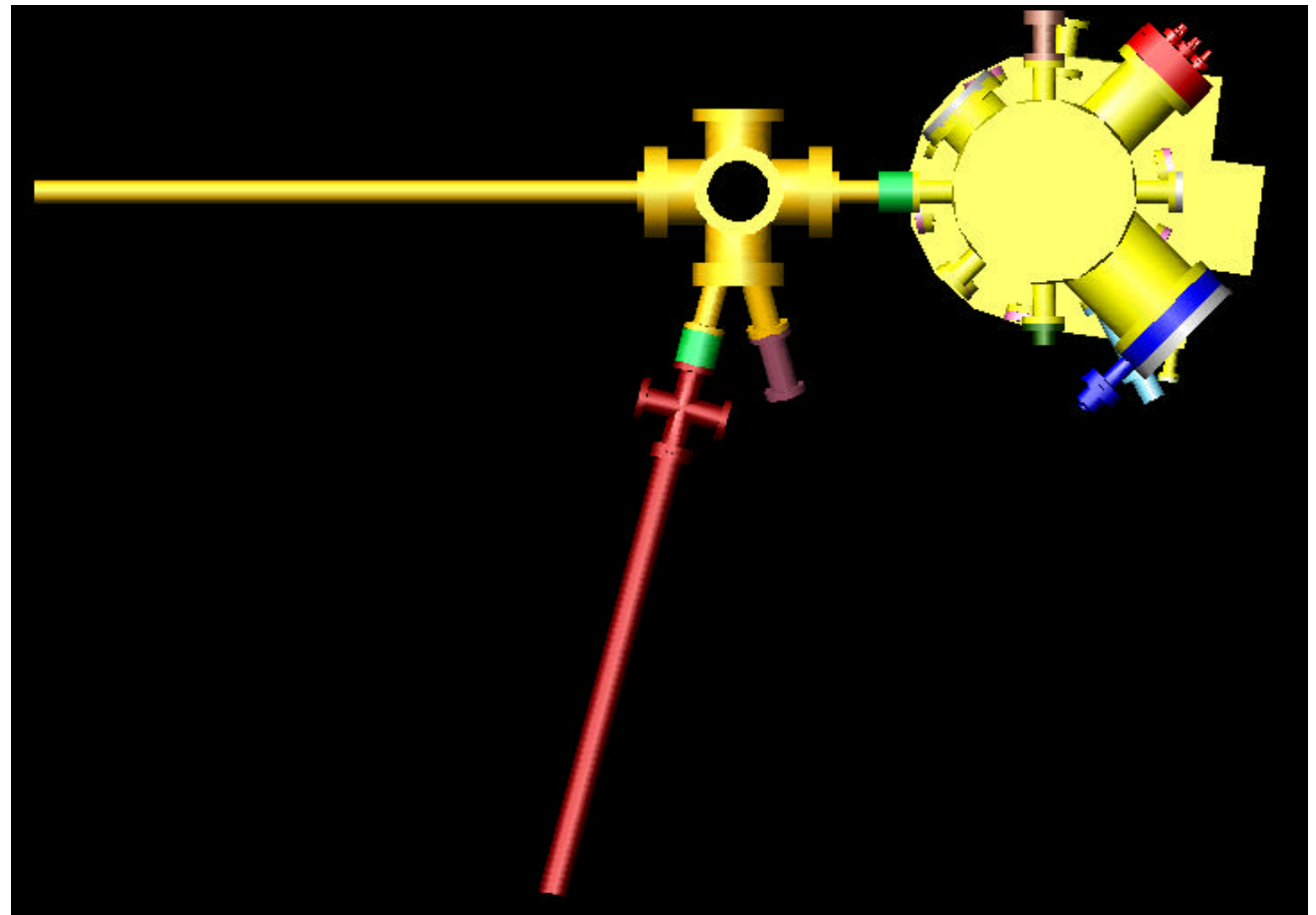


Progress to date

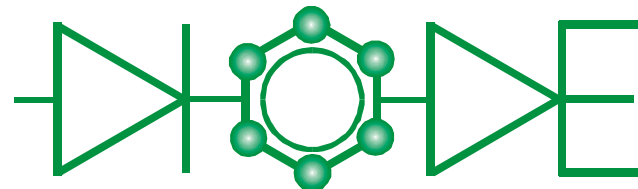


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- Designing a preparation chamber for organic thin film deposition.



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Progress to date

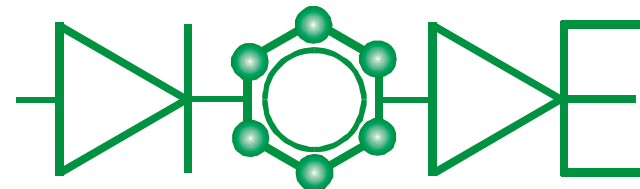


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- In-house surface characterisation (LEED, AES)
- Synchrotron radiation measurements
- Initial focus on GaAs(001) substrate preparation:
 - Argon sputtering
 - Atomic hydrogen cleaning
 - (Sulphur passivation, with UWA)
 - (Hydrogen plasma cleaning, with TUC)



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Surface preparation

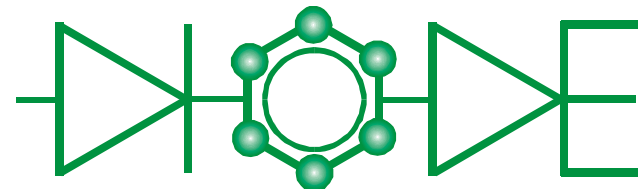


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- Argon sputtered GaAs(001)-1×6:
 - Sample sputtered for one hour at 500eV at room temperature, working pressure of 7×10^{-5} mbar, sample current of 2.5 μ A.
 - Annealed at 500°C for 20 minutes and cooling rate of 20°C/min.
- Atomic hydrogen cleaned GaAs(001)-2×1:
 - two cycles of 30000 L (equivalent to 25 mins exposure @ 2.6×10^{-5} mbar) of atomic hydrogen, one at room temperature, the second at 300°C). The room temperature treatment removes the Group V oxides while the high temperature cycle removes the Group III oxides.



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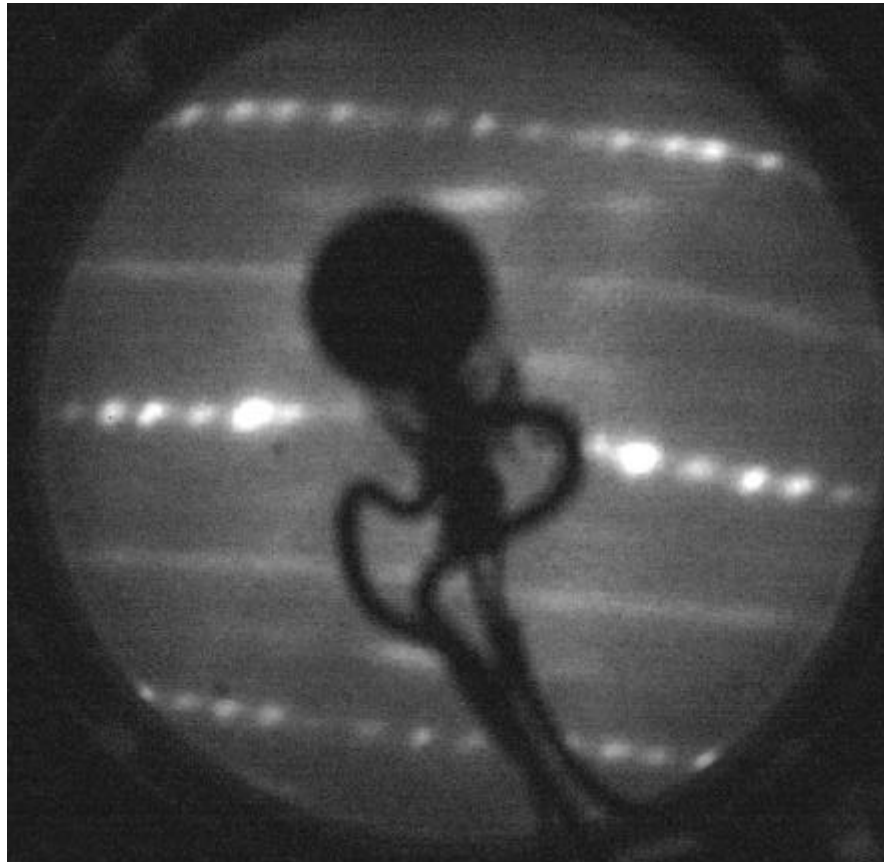


Argon sputtered surface

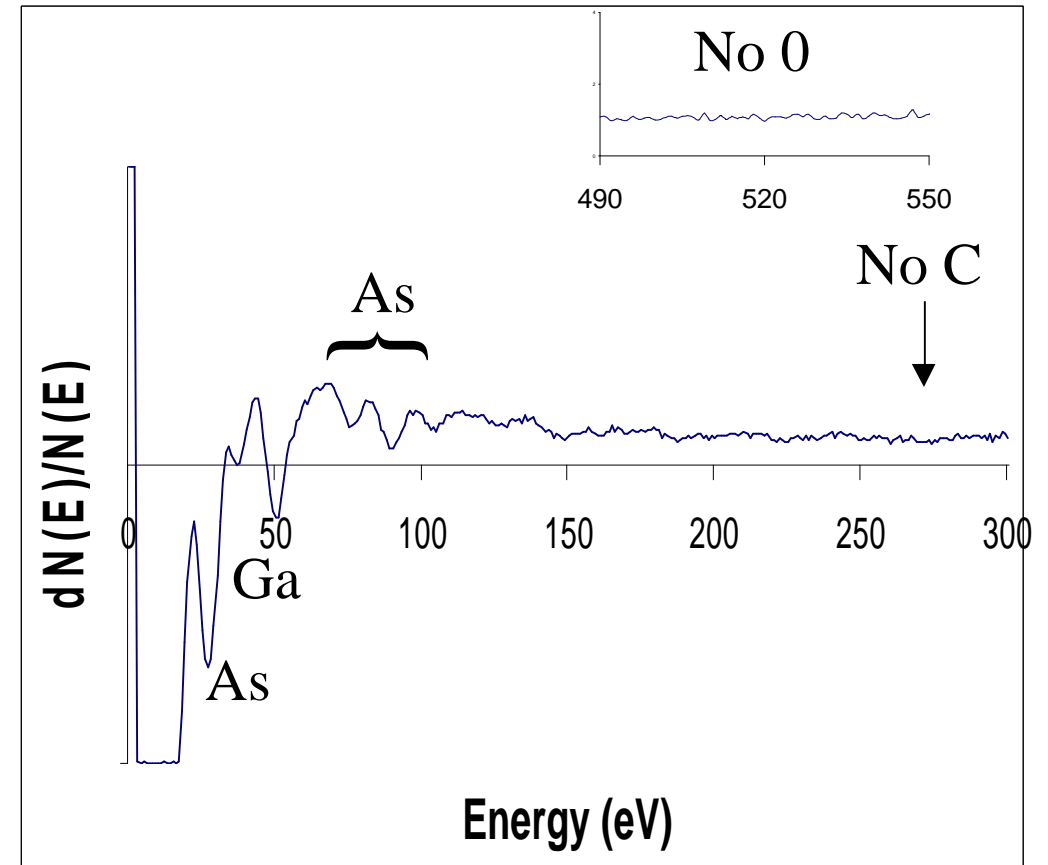


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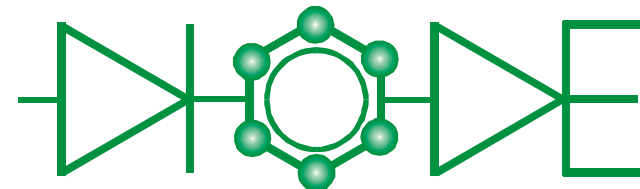
1x6 LEED pattern



AES scan



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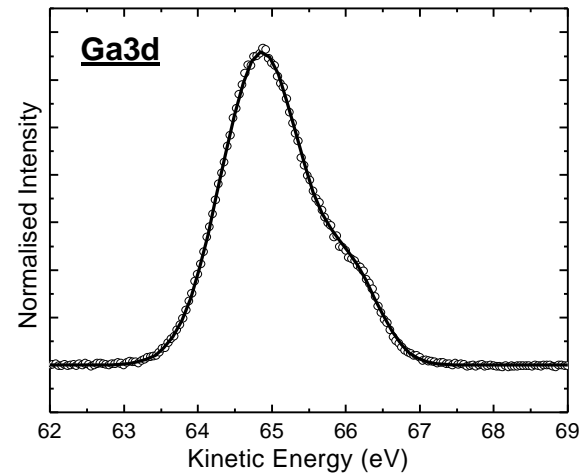
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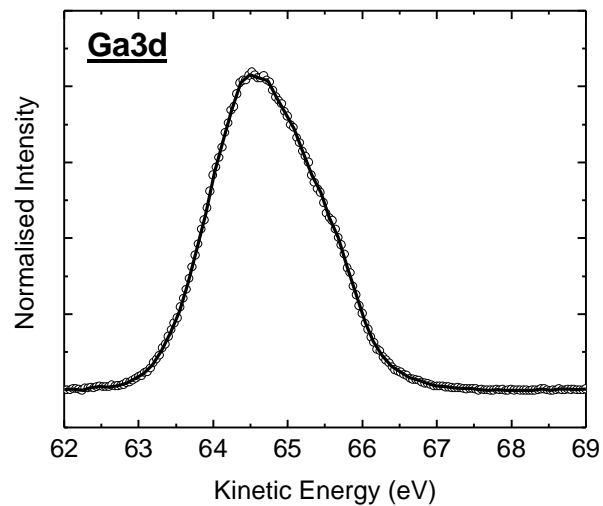
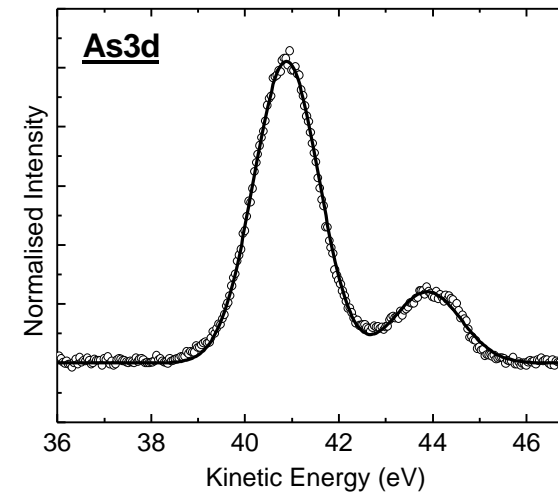
Annealing



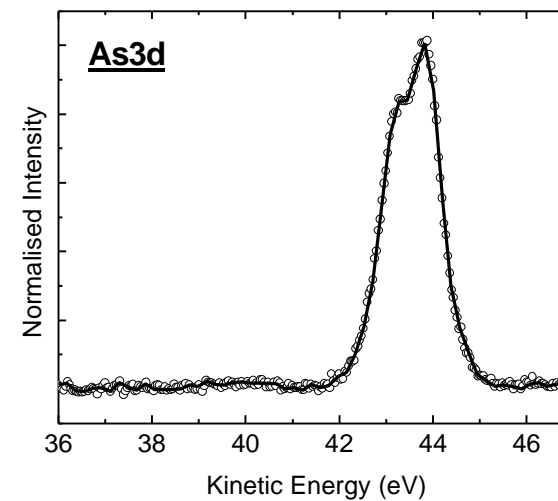
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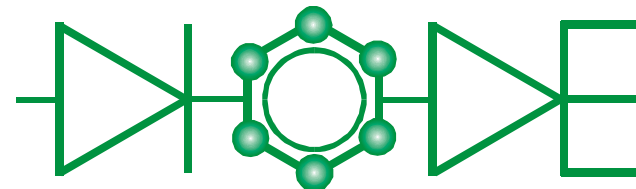
as-loaded



annealed



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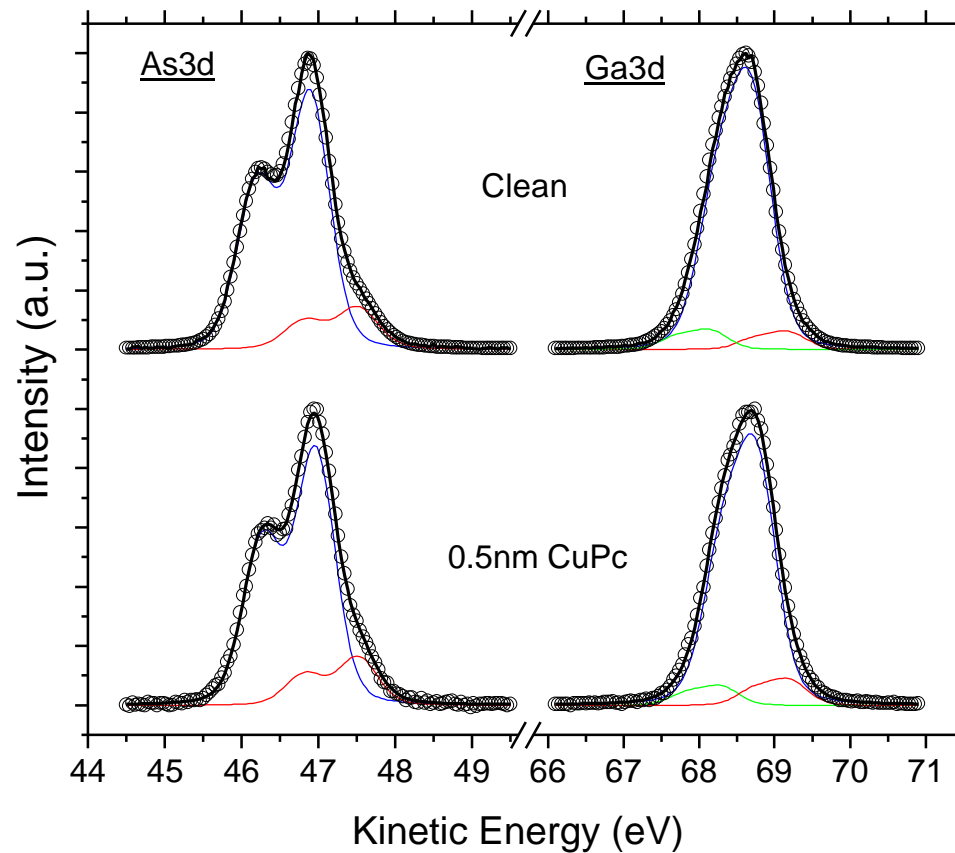
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Argon Sputtered Surface



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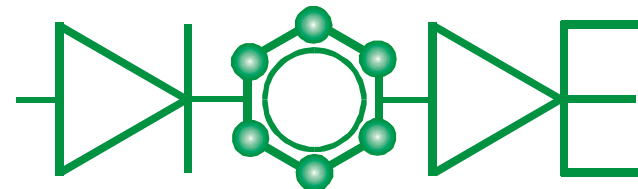


- The spectra are largely oxide-free. Upon deposition of 0.5nm of CuPc there is little variation of the respective positions and intensities of the different components. This would indicate a rather weak interaction between the GaAs and the CuPc.

Deposition rate of 1Å per minute
(working pressure of 2×10^{-9} mbar)



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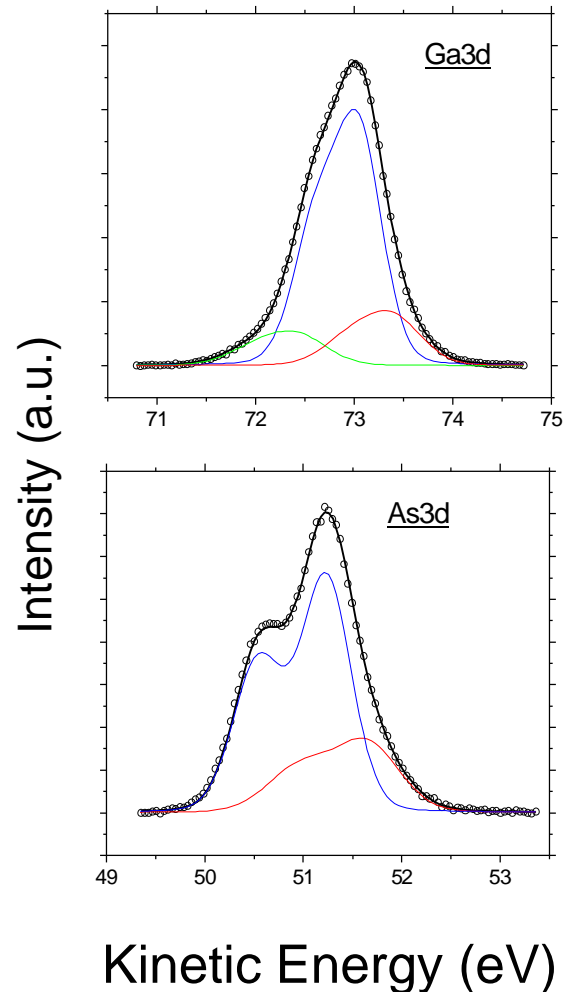
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Atomic Hydrogen Cleaning



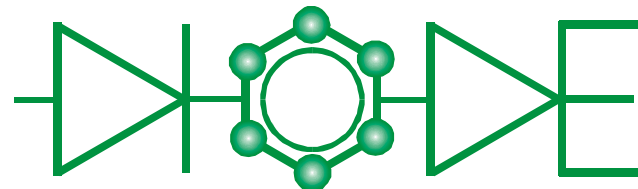
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- The final As3d spectrum shows complete removal of As-oxides and the appearance of an As surface component shifted by 0.4eV on the high kinetic energy side.
- The final Ga3d spectra also appears to be largely oxide-free. This spectrum shows a surface component shifted by 0.4eV on the high kinetic side and a further component shifted towards the low kinetic energy.
- A weak 2×1 LEED pattern was obtained after the treatment which is indicative of limited surface order.



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Summary of results

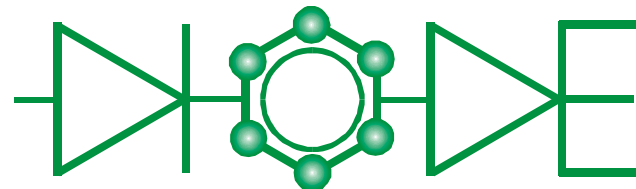


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- Reproducible substrate obtained by argon sputtering and this CuPc/GaAs interface is non-interacting
- Atomic hydrogen cleaning would encourage further work but apparatus is expensive!
- Hydrogen plasma cleaning leaves oxide of gallium
- Sulphur-passivation is reproducible and this CuPc/GaAs interface is also non-interacting



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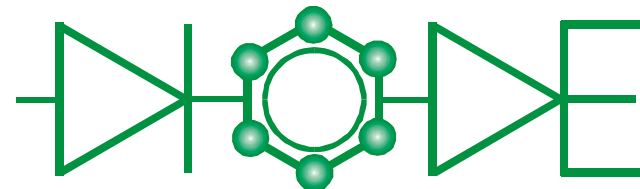
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Trips involved

- DIODE workshop, August 2000, Chemnitz
- DIODE workshop, July 2001, Aberystwyth
- ICSFS-11, July 2002, Marseille
- DPG conference, March 2001, Hamburg
- Visit to UAM, September 2001
- SRS Daresbury, in collaboration with UWA, May 2001
- BESSY, in collaboration with UWA, December 2001



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Publications

Synchrotron radiation studies of inorganic-organic semiconductor interfaces

D.A. Evans, **H.J. Steiner**, A.R. Vearey-Roberts, A. Bushell, **G. Cabailh**, S. O'Brien, **J.W. Wells**

I.T. McGovern, V. Dhanak, T.U. Kampen, D.R.T. Zahn, D. Batchelor

Nucl. Instr. and Meth. B 152 (2002) accepted, TUC, TCD, UWA

Perylenes and phthalocyanines on GaAs(001) surfaces

D.A. Evans, **H.J. Steiner**, A. Vearey-Roberts, T.U. Kampen, D.R.T. Zahn, **G. Cabailh**, S. O'Brien, and I.T. McGovern

Appl. Surf. Sci. submitted, TUC, TCD, UWA

Poster

Preparation of GaAs(001) substrates for organic deposition

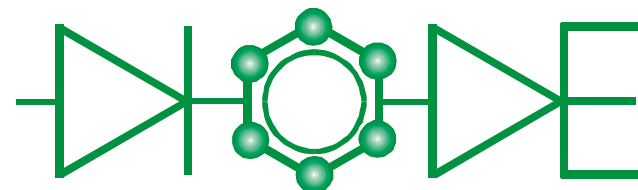
G. Cabailh, S. O'Brien, I.T. McGovern, **H.J. Steiner**, A. Vearey-Roberts, D.A. Evans,

M. Lowe, and C. McConville

TCD, UWA



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Further Work

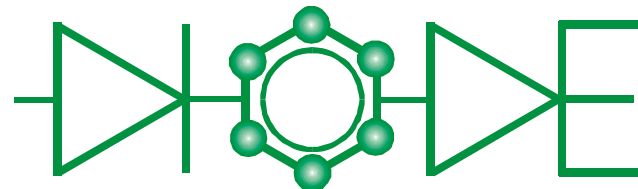


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- Thin film deposition of MgPc and PbPc on selected GaAs substrates
- Transfer sulphur-passivation techniques to TCD
- In-house XPS and UPS
- Synchrotron radiation SXPS, NEXAFS, etc
- STM/AFM



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Network Impressions

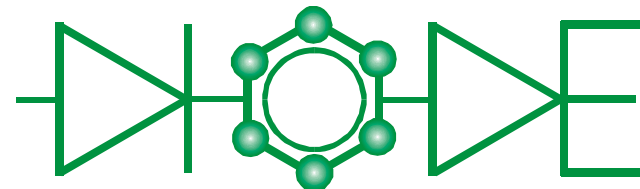


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- Remarks:
 - Communication between young researchers needs to be enhanced.
 - Training and collaboration trips need to be done on a longer period (e.g. 4 to 6 weeks).
- Synchrotron work was a very good experience.
- Visit to Madrid enabled to learn other techniques (STM, AFM).
- Overall positive experience.



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