Development of GaN etching in the **Plasma**Pro **NGP**1000 System

Providing batch production solutions for the HBLED market

Andy Goodyear, Geoff Hassall, Stephanie Baclet, Oxford Instruments

High Brightness LEDs (HBLEDs) are rapidly replacing traditional light sources in many applications, such as TV and laptop screen backlighting and even general lighting, since HBLEDs offer a very efficient light source in a compact package with a very long lifetime. The large demand for LEDs requires production equipment with a high throughput.

Oxford Instruments Plasma Technology (OIPT) has been the world leading supplier of high volume batch plasma tools in the production market for over 15 years, with a wide installed base of HBLED production systems in operation.

Gallium Nitride (GaN) etching is a key part of the HBLED production process. OIPT has developed a large batch tool for GaN etching, based on the **Plasma**Pro **NGP**1000 production tool platform. This tool uses the newly introduced Etch plasma source, which provides excellent uniformity over large areas. By delivering power in the VHF band this source provides a high plasma density comparable with current OIPT ICP sources and maintains the benefits of high etch rates but in a low damage environment.

Operating at VHF requires careful design of the plasma source hardware and chamber components to minimise undesirable electromagnetic effects, asymmetries and non-uniformities that degrade the process across a batch of wafers. The design parameters are now well understood and can be tailored to meet specific process requirements.

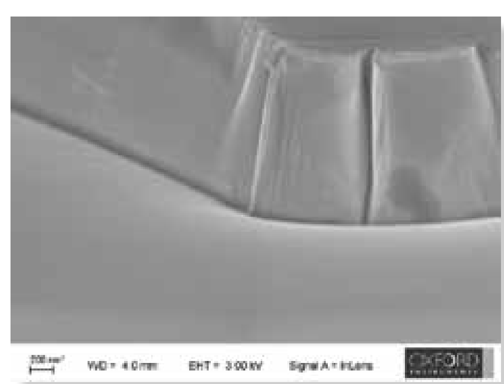
A GaN etching process has been developed that provides 55 x 2″ wafer batch etching rates in excess of 140nm/min, selectivity to photoresist ~1:1, and uniformities wafer-to-wafer and across-wafer <±5%. Etched surfaces were found to be smooth across the whole batch and across many runs.

The process has been successfully transferred to the OIPT's newly opened Far East Applications Laboratory based at ITRI, Taiwan, in readiness for customer demonstrations.

Market leading etch batch sizes of up to 55 x 2", 13 x 4" or 5 x 6" wafers

Large diameter electrode enables exceptional wafer batch sizes, resulting in maximum throughput and low cost of ownership

Wafer size	Number of wafers		
	PECVD	Unclamped etch	Clamped and He cooled etch
450mm	1	1	1
12″ (300mm)	1	1	1
8″ (200mm)	3	2	2
6″ (150mm)	7	5	5
4″ (100mm)	15	13	12
2″ (50mm)	61	55	43



SEM image of the etched GaN surface near a masked edge, (photoresist removed)

For more information on this innovative new HBLED production solution, contact **plasma@oxinst.com**

Expansion strengthens our company offering

Delivering major benefits to our customers

A major expansion and improvement programme at Oxford Instruments Plasma Technology is delivering major benefits to customers. Investment in a number of key areas of the business has resulted in faster and more streamlined manufacturing, superior research facilities and more comprehensive customer support.

"Our workforce has grown by over 30% in the past 12 months enabling us to react quickly to our significantly increased order book, and to provide faster product and process development for our customers", comments Andy Matthews, MD of Oxford Instruments Plasma Technology.

The company has incorporated parallel build and test bays in Manufacturing for production of its etch, deposition and growth equipment, offering more flexibility to respond to customer requirements, and reducing manufacturing lead times. This has resulted in more efficient manufacturing processes for repeat products, in supplying equipment for instance to the fast growing HBLED production market. These extensive changes have increased our production capacity by approximately 50%.

New R&D and applications laboratories have been built with expanded capabilities, and a number of newly appointed Process Engineers. The applications laboratories house the company's range of etch, deposition and growth equipment, including **Plasma**Pro, **FlexAL** ALD and Nanofab nanoscale growth tools manufactured at the Bristol, UK facility, where customer samples are run, and new processes developed.

Dedicated engineering and software development suites, and a specialist training department have also been created in order to maximise the company's capacity to deliver quality tools and support to its customers.

"This major investment in both staff and facilities supports our ability to meet the needs of our diverse customer base", says Dan Ayres, General Manager at Oxford Instruments Plasma Technology, *"alongside our global team and supply base we're able to continuously improve our quality and delivery performance whilst innovating our product and process offering."*

"As a leader in high technology equipment manufacture, we have responded to the demands of our industry to ensure we are as competitive as possible, and to retain our reputation for producing world class products and creating long term relationships with our customers based on trust and respect."

Andy Matthews, MD of Oxford Instruments Plasma Technology

Plasma etching of high-resolution features in a fullerene molecular resist

J. Manyam, M. Manickam, J.A. Preece, R.E. Palmer, A.P.G. Robinson, University of Birmingham

As resist films become thinner, in order to reduce problems of aspect-ratio-related pattern collapse at high-resolution, it is becoming increasingly difficult to transfer patterns with useful aspect ratio by directly etching the resist.

It has become common to use the photoresist to pattern an intermediate hardmask or, more recently, multilayer hardmask stacks[1], which then protect the silicon substrate during etching, allowing useful aspect ratios but adding significant process complexity.

We have developed a high etch durability fullerene based chemically amplified resist which permits the use of films as thin as 30 nm for high resolution applications whilst retaining sufficient etch resistance, to allow the transfer of useful aspect ratios into a silicon substrate with a simple room temperature SF_6 and fluorocarbon mixed mode etching process. Through the use of the high carbon content resist and careful control of the etching parameters, it has been possible to transfer 20 nm resist features with aspect ratios in excess of 5:1, at silicon etch rates of up to 9 nm/s, without the need for hardmasks[2]. Whilst it is possible to achieve similar resolution and etch depth performance using a cryogenic etch, this requires more complex equipment and suffers from a very low etch rate of less than 1.5 nm/s, and problems such as pattern cracking related to the use of low temperatures.

In order to successfully transfer high-resolution patterns from 30 nm resist films into silicon an extensive study of the effects of ICP and RF power, etchants, pressure and other etching parameters was undertaken[2]. In particular the capability of the Oxford Instruments **Plasma**Pro **NGP**80 to run short etch cycles of 20 seconds or less was important when processing such thin photoresist films. Figure 1 shows a set of 20 nm lines patterned at a pitch of 50 nm in a 30 nm thick fullerene resist film and etched for 25 seconds to a depth of 80 nm using an $SF_6 – C_4F_8$ etch at a pressure of 30 mT, ICP power of 220 W and at room temperature. Figure 2 shows the results of switching the fluorocarbon to CHF_3, reducing the ICP power by 20 W and the etch duration by 5 seconds. 20 nm features were etched to an overall depth of 140 nm. In both cases the resist was removed after etching and before imaging using an O_2 etch.

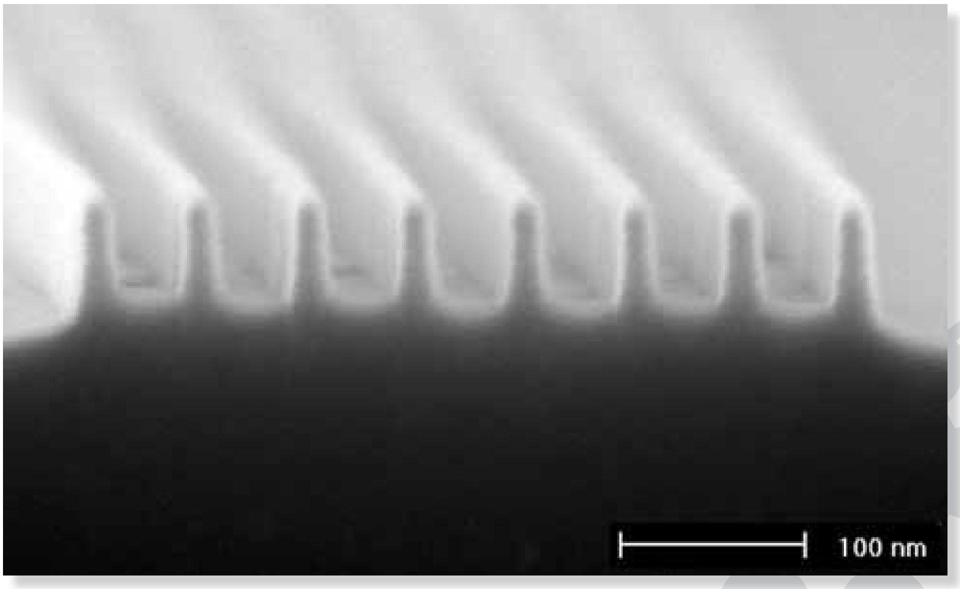


Figure 1. *20 nm lines patterned in a 30 nm thick resist film with electron beam lithography and etched to a depth of 80 nm using $SF_6 – C_4F_8$ mixed mode etching in an Oxford Instruments **Plasma**Pro **NGP**80 ICP system.*

[1] M. Weimer, Y. Wang, C.J. Neef, J. Claypool, K. Edwards, Z. Su, Proceedings of SPIE, 6519, 65192S (2007)

[2] J. Manyam, M. Manickam, J.A. Preece, R.E. Palmer, A.P.G. Robinson, Proceedings of SPIE, 7972 (2011)

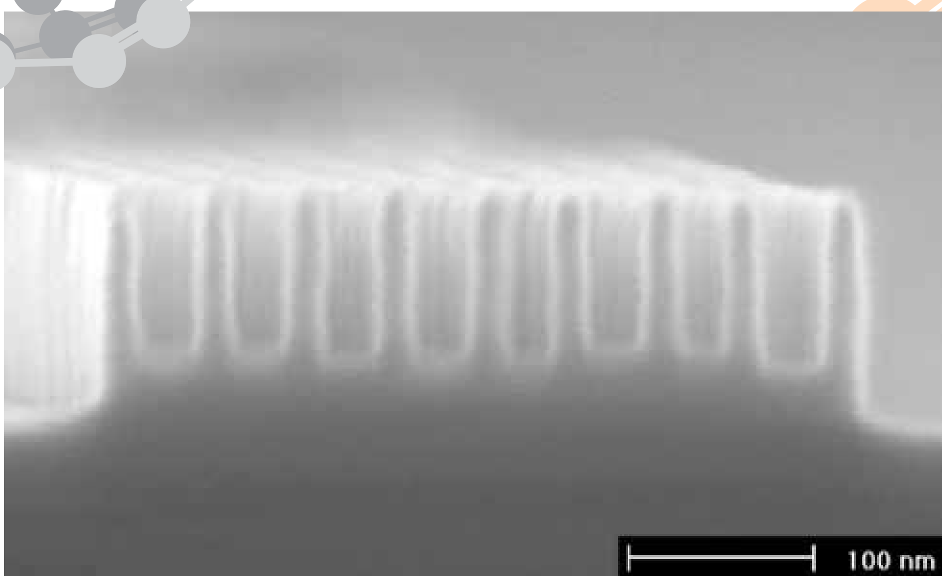


Figure 2. *20 nm features patterned in a 30 nm thick resist film with electron beam lithography and etched to a depth of 105 nm between the features and 140 nm overall etch depth using* SF_6*-*CHF_3 *process.*

Summary

Increasing resolutions required ever thinner resist films, and to date this has meant significant increase in process complexity for sub 50 nm pattern transfer. Using high carbon content fullerene electron beam resist and a short duration mixed mode etching process it was possible to successfully transfer 20 nm features with an etch rate of 9 nm/s and aspect ratios in excess of 5:1.

New technology patents granted

We continue to develop new technologies, and are pleased to announce our recently patented work below:

The hot table technology developed by Nick Singh and Roger Croad underpins our high temperature PECVD and 700C **Nanofab**® products (Patent number: EP1695370B1)

The process recipe strategy patent invented by Andy Goodyear and Phil Rossbrook is an advanced method for changing process parameters dynamically during a process (Patent number: EP1877878B1)

The double chamber reactor developed by Nick Singh and Phil Burns relates to our ALD product line. (Patent number: GB 2426252)

ALD of magnetic materials used for the synthesis of nanotubes

Robert Zierold, Julien Bachmann, Kornelius Nielsch
Institute of Applied Physics, University of Hamburg

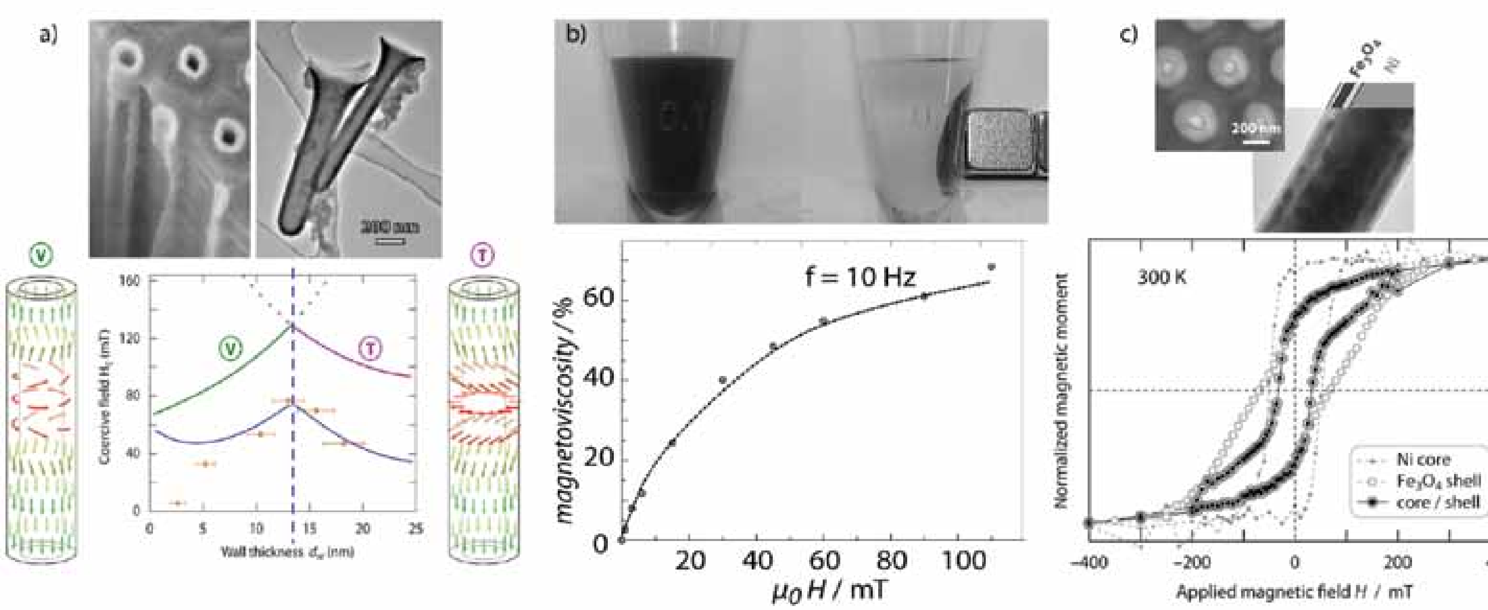
The self-limiting nature of Atomic Layer Deposition (ALD) allows for very long exposure times – resulting in long diffusion times for the gaseous precursor molecules – which leads to conformal deposition of very complex nanostructures without any shadowed area.

The ALD of iron oxide[1] and silica[2] applied onto tailor-made porous alumina membranes (40-450 nm pore diameter; aspect ratios between 2 and 1000) enables the experimentalist to synthesize three-layered nanotubes. The thickness of each layer is independently tunable by the number of ALD cycles applied. These nanotubes embedded in the alumina matrix exhibit magnetic behavior after reduction to Fe_3O_4 in argon-hydrogen-atmosphere. They can be subsequently released by a selective wet-chemical etching of the template structure. During this, the silica layer protects the iron oxide from dissolution and aerobic reoxidation.

These customized nanotubes give new insights into physical fundamentals about the magnetic reversal mechanism of tubular structures in arrays. Shifting the wall thickness over a critical value at will results in a change from "vortex" reversal to a "transverse" reversal of the magnetization[3].

Furthermore, short nanotubes suspended in a carrier liquid can be used as ferrofluid[4] – a liquid suspension of (magnetic) nanoparticles – the viscosity of which is a function of the external magnetic field applied. Ferrofluidic liquids of such magnetic, tubular nanorods are expected to be more sensitive to the magnetic field than comparable spheres, because of their permanent magnetization. They should also be more resistant in terms of fluid mechanics against shear forces. Additionally, such nanotubes made out of biocompatible materials and with their hollow inner volume might pave the way to a new class of inorganic medical carriers.

Nanotubes by ALD facilitate the synthesis of core-shell nanowires, whereby a magnetic nickel core is electrochemically deposited in nanotube array embedded in the alumina template. Magnetic characterization of such arrays show hysteresis curves with well-separated magnetization reversals



Reprinted with permission from Bachmann, J.; Escrig, J.; Pitzschel, K.; Moreno, J. M. M.; Jing, J.; Gorlitz, D.; Altbir, D. & Nielsch, K., J. Appl. Phys., Vol. 105, Page 07B521, (2009). Copyright 2009, American Institute of Physics.

Reproduced with permission from Chong, Y. T.; Gorlitz, D.; Martens, S.; Yau, M. Y. E.; Allende, S.; Bachmann, J. & Nielsch, K.: Multilayered core/shell nanowires displaying two distinct magnetic switching events. Adv Mater, 2010, 22, 2435-9 and Zierold, R.; Wu, Z.; Biskupek, J.; Kaiser, U.; Bachmann, J.; Krill III, C.E. & Nielsch, K.: Magnetic, Multilayered Nanotubes of Low Aspect Ratios for Liquid Suspensions. Adv Funct Mater, 2011, 21, 226-232. Copyright Wiley-VCH Verlag GmbH & Co. KGaA.

[1] Bachmann et al, J. Am. Chem. Soc., **2007**, 129, 9554-9555
[2] Bachmann et al, Angew. Chem. Int. Ed., **2008**, 47, 6177-6179
[3] Bachmann et al, J. Appl. Phys., **2009**, 105, 07B521
[4] Zierold et al, Adv. Funct. Mat., **2011**, 21, 226-232
[5] Chong et al, Adv. Mater., **2010**, 22, 2435-9

for the iron oxide shell and the nickel core[5]. In a nanotube or nanowires a bit of information can be stored in terms of the remnant magnetization looking up or down along the tubes axis. In the future, the core-shell nanotubes might be a possibility to store two bits (down/down, up/down, down/up, up/up for core and shell, respectively).

Prospectively, atomic layer deposition of magnetic materials in combination with templates might open the scope of application for ALD away from the classical field of semiconductors and dielectrics towards new areas, for example in medicine and data storage.

Figure 1 *a) Top left: SEM micrograph of iron oxide nanotubes embedded in the alumina membrane. On the right: TEM micrograph of released nanotubes showing smooth, homogenously thick walls. At the lower panel, the transition between the vortex and the transverse magnetization reversal in nanotubes appears as a maximum in the plot of the coercive vs. the wall thickness [2,3].*

b) Top: Using a magnetic field gradient allows for the separation of the suspended magnetic nanotubes; removing the magnet and shaking the Eppendorf reverts the sample to its initial well suspended state. Bottom: Application of a magnetic field increases the viscosity by aligning the tubes along the magnetic field [4].

c) Top: SEM micrograph (top view) of core/shell nanowires embedded in the membrane and a TEM micrograph showing the core/shell structure in side view. Underneath, the magnetic hysteresis curve of core/shell structures reveals the presence of the characteristics of both isolated components – only shell and only core, respectively [5].

Supplying plasma systems for nano discovery at Notre Dame

The Midwest Institute for Nanoelectronics Discovery (MIND), USA, recently purchased two plasma etch and deposition systems from us to further expand and facilitate its research capabilities.

The **FlexAL**® Atomic Layer Deposition (ALD) system and the **Plasma**Pro System100 ICP etch system, are being installed in the Notre Dame Nanofabrication Facility, a 9,000 sq. ft. cleanroom at the University of Notre Dame, Indiana, USA.

FlexAL systems provide a new level of flexibility and capability in the engineering of nanoscale structures and devices by offering remote plasma ALD processes and thermal ALD within a single system. The **Plasma**Pro System100 ICP etch system features the new Cobra source which provides the user with additional plasma control capabilities, thereby providing the highest flexibility for advanced processing.

Comments Professor Alan Seabaugh of Notre Dame, the Frank M. Freimann director of MIND, *"The goal of the NRI centers is to discover and develop the next nanoscale logic device – one with performance capabilities beyond conventional devices, enabling it to become the basic building block of future computers. At Notre Dame, we have chosen Oxford Instruments' systems to facilitate this work, due to the advanced features they provide; the versatility and cost effectiveness of their systems for research and the support the company offers."*

We've increased our Process, Sales and Service teams recently and recruited staff throughout our company

Victor (Hong) Wang
Sales Manager, North China

Stephen (YC) Yang
Field Process Engineer Asia

Shawn Xu
Field Process Engineer, USA

Brodie Mackenzie
Applications Engineer, UK

Sunny Sun (Sun Ni)
Sales Manager, East China

Gary Proudfoot
Senior Technologist, UK

John Hutchings
Field Process Engineer, UK

Dr Louise Bailey
Technology Development Engineer, UK

Joseph Chen
Head of Sales, China

Young Huang
Senior Applications Engineer, Taiwan

David Woodgate
Field Customer Support Engineer, UK

Daimy Zhang
Sales Manager, South China

Deposition of Al_2O_3 film for potential application to surface passivation of solar cells

Dr Cigang Xu, Senior Development Scientist, Oxford Instruments

It is reported that Al_2O_3 films can provide good surface passivation for crystallin solar cells, and it can demonstrate thermal stability and UV stability, which is ess for the application of Al_2O_3 passivation in high-volume manufactured solar cells.

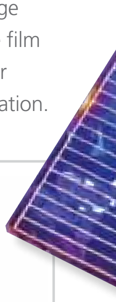
Various techniques have been employed to deposit Al_2O_3 films for the application of surface passivation, including atomic layer deposition (ALD), microwave-remote plasma-enhanced chemical vapour deposition (PECVD) and RF magnetron sputtering.[3] It is still in the early stages to decide which method can provide a more suitable process for the deposition of Al_2O_3 film in solar cell mass production. Here we show the deposition of Al_2O_3 by a radio frequency-based plasma-enhanced chemical vapour deposition (PECVD) process, which can provide various deposition rates and refractive indexes.

The Oxford Instruments System133 PECVD tool in the application laboratory was used in order to characterize the process. The Al precursor used was TMA (trimethyl aluminum); the oxidant was N_2O although O_2 could be a possible alternative. The samples were either 8 inch silicon wafers or small silicon pieces for which a 6 inch carrier wafer was used. To optimize the process conditions, one process parameter was varied while other parameters were kept constant. The resulting samples were characterized by ellipsometry to determine the thickness and refractive index (RI), and XPS to study the composition of the films.

As an example, to study the effect of the process temperature, 8 inch sample wafers were used, positioned directly on the susceptor. Figure 1 shows that the deposition rate is similar for temperatures across the range investigated, but the RI increased fairly linearly with increasing temperature, indicating the change of the composition of the films with the increase of temperature.

The Al_2O_3 film composition was also characterized using XPS and included a depth profile analysis. Figure 2 shows the depth profile analysis using XPS for the film deposited at 400°C with a refractive index of about 1.65. The amount of N and C is very low, the composition at mid profile is as follows: 45% Al, 55% O, N and C content is < 0.5%, this indicates that the film is oxygen rich although the oxygen content is slightly lower than perfectly stoichiometric aluminum oxide by ~5%, coinciding with a 5% higher aluminum content.

In summary, PECVD processes for the deposition of Al_2O_3 film have been successfully demonstrated, with the deposition rate in the range of a few nanometers up to tens of nanometers. Various process conditions have been tested, such as the RF power, gas flow and temperature. The characterization shows that the process parameters affect one another, and a wide range of process conditions are available for the deposition of Al_2O_3 film. The film has very good thickness uniformity of <5% across 8 inch wafer. Further optimization and study of the properties of Al_2O_3 film is worth investigation.



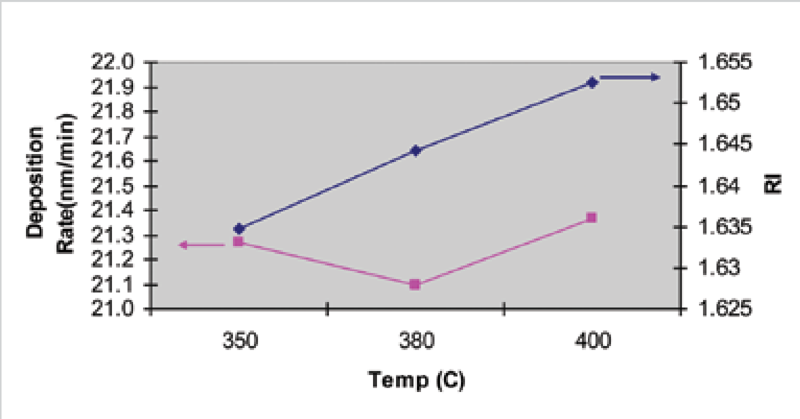


Figure 1: The effect of temperature on the deposition of Al_2O_3 film

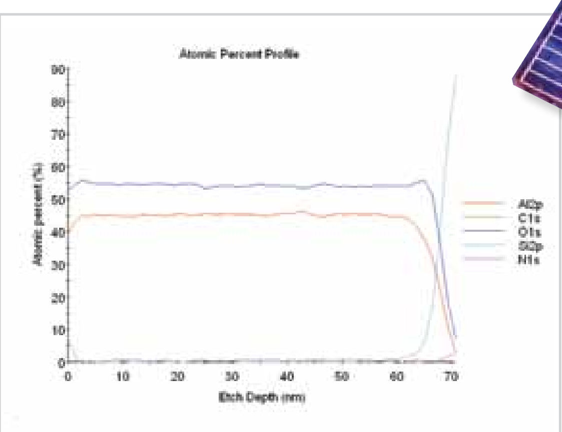


Figure 2: XPS depth profile for the Al_2O_3 film

e silicon
ential
1,2

Good thickness uniformity proven

Reference:

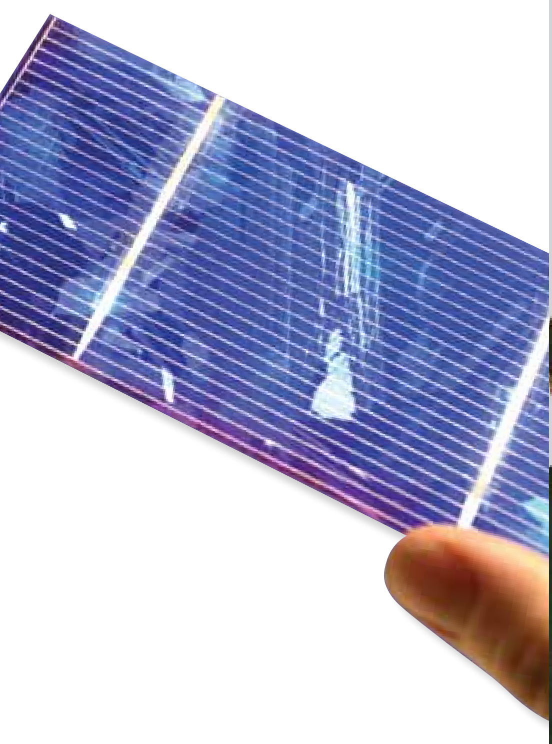
1 B. Hoex, J.Schmidt, P. Pohl, M.C.M. van de Sanden, and W.M.M. Kessels, J Appl. Phys. 104, 044903 (2008)

2 G. Dingemans, P. Engelhart, R. Seguin, F. Einsele, B. Hoex, M.C.M. van de Sanden, and W.M.M. Kessels, J Appl. Phys. 106, 114907 (2009)

3 J Schmidt, F. Werner, B. Veith, D. Zielke, R. Bock, V. Tiba, P. Poodt, F. Roozeboom, A. Li, A. Cuevas and R. Brendel, 25th European Photovoltaic Solar Energy Conference, Valencia, Spain, Sept. 2010, 2AO.1.6

Acknowledgement

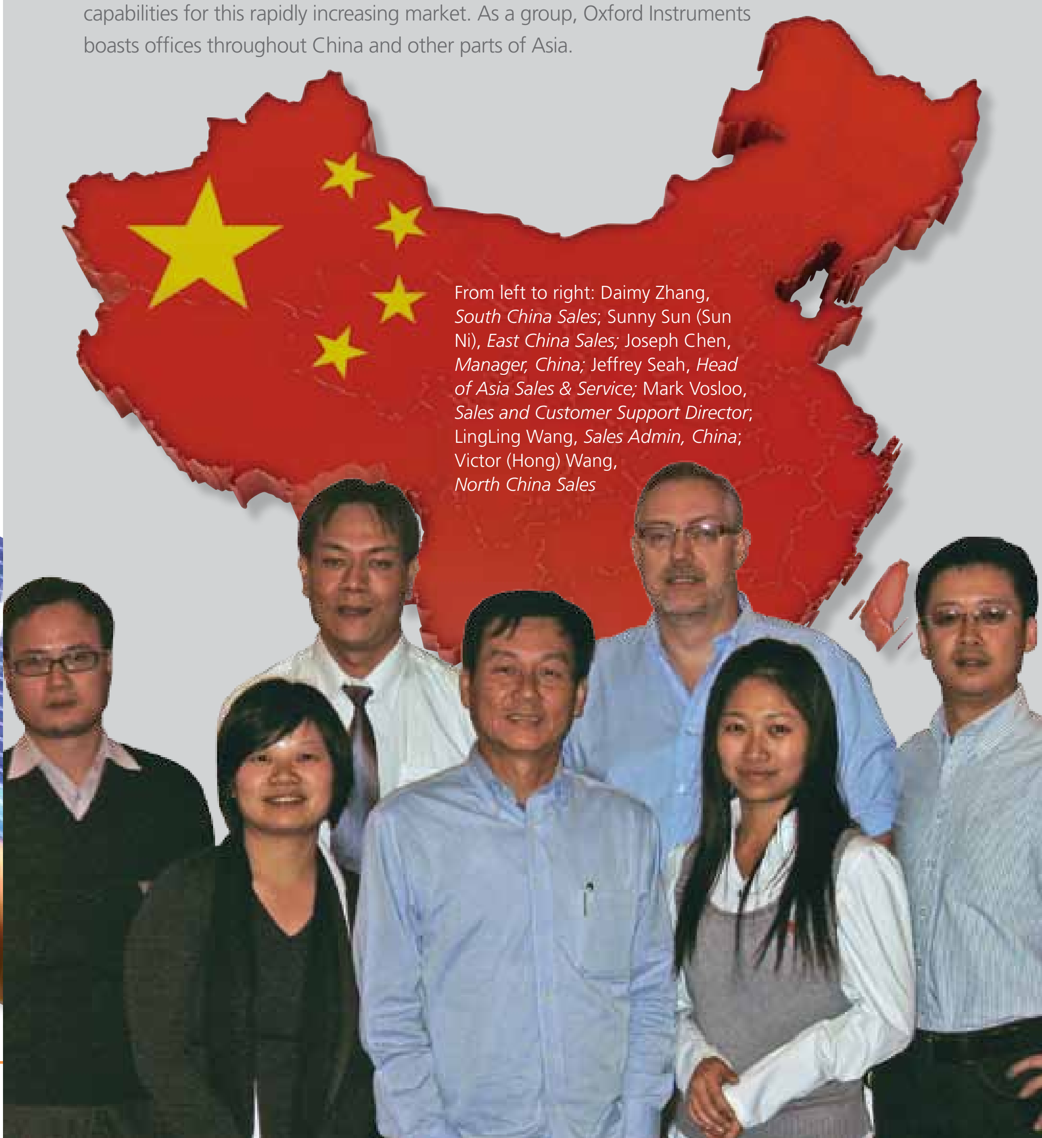
This work was supported by EC FP7 contract 241281 FP7-ENERGY-2009-1



Continuing expansion in China

Responding to increased market demand for our systems in China, we've significantly expanded our resources in that region. With offices situated in Shanghai, Beijing and Guangzhou, the company has recently recruited additional sales, service and administrative support, to maintain and increase our already high level of customer contact and support.

We have been established in China for many years, and understand how crucial it is to grow our high level, locally based, dedicated team and support our extensive process solution capabilities for this rapidly increasing market. As a group, Oxford Instruments boasts offices throughout China and other parts of Asia.



From left to right: Daimy Zhang, *South China Sales*; Sunny Sun (Sun Ni), *East China Sales;* Joseph Chen, *Manager, China;* Jeffrey Seah, *Head of Asia Sales & Service;* Mark Vosloo, *Sales and Customer Support Director*, LingLing Wang, *Sales Admin, China*; Victor (Hong) Wang, *North China Sales*

HIT solar cell development at Fraunhofer Institute for Solar Energy Systems (ISE)

Knut Beekmann, Product Manager, Oxford Instruments

The heterojunction with intrinsic thin layer or HIT solar cell was first introduced by Sanyo
is currently held by Sanyo and stands at 23% (lab efficiency). The basic layer structure of
be considered as a hybrid between high quality crystalline silicon cells and low cost amo

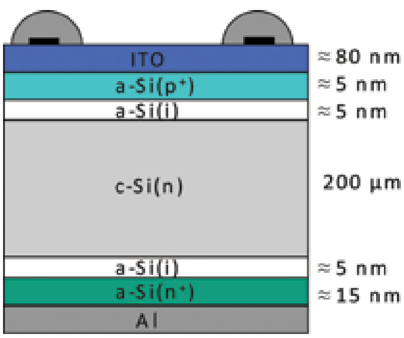


Figure 1. *HIT cell structure*

The main differences between the HIT cell and a more traditional crystalline silicon cell are the introduction of different semiconductor materials to create the pn-junction and back surface field, the inclusion of an intrinsic layer and the addition of a transparent conducting oxide. This leads to superior conversion efficiency performance compared with conventional crystalline silicon cells when operating at higher temperatures. A significant advantage in the manufacturing process of HIT cells is the reduction in thermal budget. Temperatures of up to 1000°C are required for dopant diffusion in order to form the pn-junction. The HIT cell doped layers are typically formed by PECVD processes below 350°C.

The more symmetrical structure of the HIT cell also reduces mechanical and thermal stresses.

A key factor in improving HIT cell performance is the inclusion of the intrinsic amorphous silicon layer. The intrinsic film provides very good passivation of the silicon surface by reducing interface defect density.

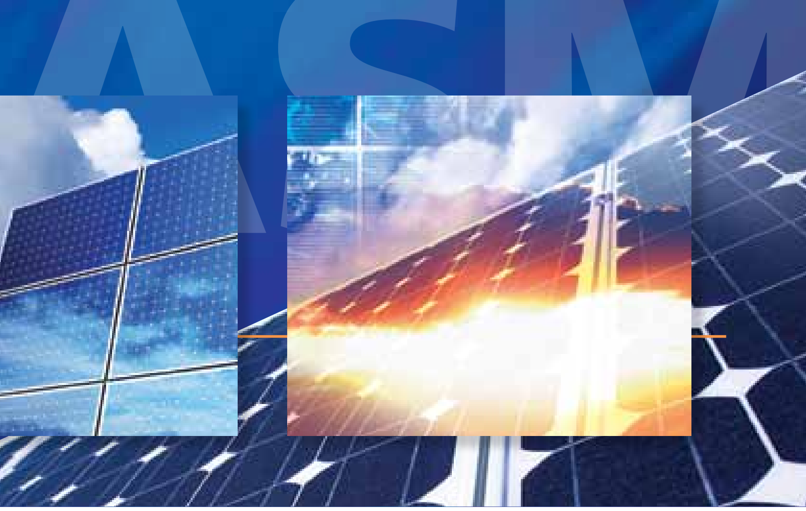
Process Development

Fraunhofer ISE has undertaken an extensive development program and in one particular aspect, to optimise the intrinsic film deposition methodology and processes using a PlasmaPro System100 cluster tool as shown in figure 2. The system consists of a remote inductively coupled plasma chemical vapour deposition module (ICPCVD), parallel plate plasma enhanced chemical vapour deposition module (PECVD) and sputter process module. Options such as variable height tables and the ability to ramp gas flows and plasma power are also included.

Figure 2. ***Plasma****Pro System100 installed at FhG ISE*

Process characterisations were carried out comparing parallel plate PECVD with ICPCVD depositions in order to achieve the best intrinsic layers. Passivation properties were determined by measurements of minority carrier lifetime using crystalline silicon substrates. A key target is to achieve high carrier lifetime for low intrinsic film thickness of ~5 to 10 nm. Results were also monitored against time for as deposited and post annealed samples which, in each case, showed time dependent lifetime degradation. This information dictated a strict timing regime for lifetime measurements to enable comparison between processes. Statistical designs of experiment were used to highlight the key parameter or parameter combinations that have the most significant effect on carrier lifetime. The results of these experiments are summarised for both ICPCVD and parallel plate PECVD in figure 3 and figure 4 respectively. The PECVD samples also showed significant trend shifts depending on whether the samples were measured as deposited or after annealing at 250°C for 10 minutes.

Optimised intrinsic amorphous silicon processes were developed for both the ICPCVD and parallel plate PECVD modules and these were then compared for passivation quality against film thickness. The results are shown in figure 5.



in 1992. The record efficiency for such a cell
a typical HIT cell is shown in figure 1 and can
rphous silicon thin film technology.

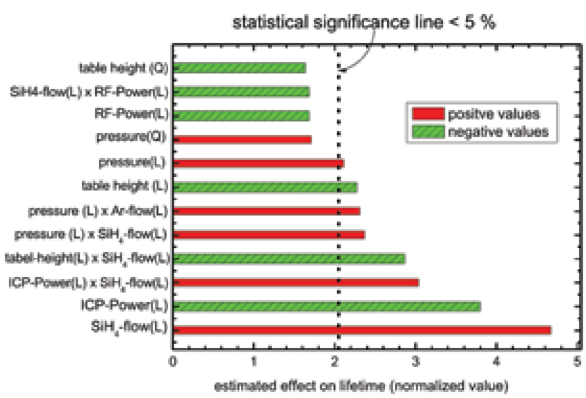


Figure 3. Relative significance of ICP deposition parameters on lifetime

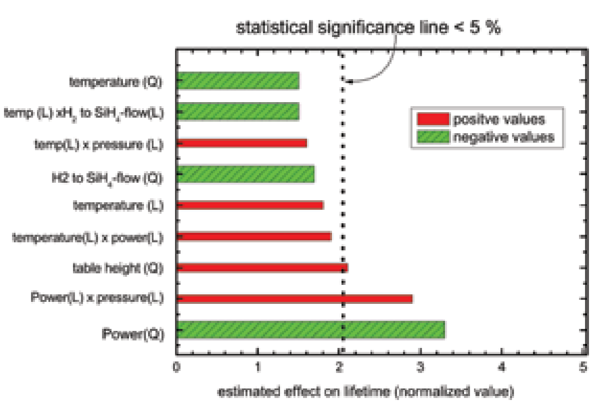


Figure 4. Relative significance of parallel plate PECVD deposition parameters on lifetime

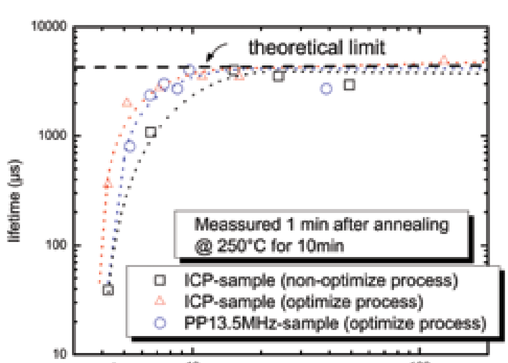


Figure 5. Thickness dependence and process comparison of passivated lifetimes

Impressive five module cluster tool shipped for growing PV market

We recently shipped a five module cluster system to Robert Bosch, one of the world's leading manufacturers of solar cells. The System100Pro deposition tool is a 'Hex Handler' providing capabilities for several deposition technologies, and allowing multiple process steps to be carried out without a vacuum break.

This five module tool for such a prestigious customer has allowed us to successfully integrate multiple technologies into the cluster, such as the ability to run both ALD and plasma CVD aluminium oxide depositions. With the increasing trend towards generating energy by renewable means, we are establishing ourselves as a key supplier to the growing PV R&D market.

Summary

Using the **Plasma**Pro System100, process optimisation of both ICPCVD and parallel plate PECVD confirmed that a good passivation can be achieved by both methods. Softer or low damage depositions provide better passivation quality however, for thin intrinsic amorphous silicon layers below 7 nm, the ICPCVD method produces the best minority carrier lifetime results.

Best solar cell efficiencies have also been determined for the two deposition methodologies. Results are quite similar but again, the ICPCVD showed an improvement over the parallel plate PECVD with a cell efficiency of 18.7% as opposed to 18.5%.

Acknowledgement

Thanks to Damian Pysch, Martin Bivour, Karin Zimmermann, Christian Schetter, Martin Hermle and Stefan Glunz of FhG ISE for guidance, data and the information included in this article.

Nanoscale etching in Oxford Instruments ICP systems

Colin Welch, Principal Applications Engineer, Oxford Instruments

Oxford Instruments Plasma Technology has been working on nanoscale etching (feature sizes below 100 nm) for many years now and we are continually adding to our 'portfolio' of materials etched.

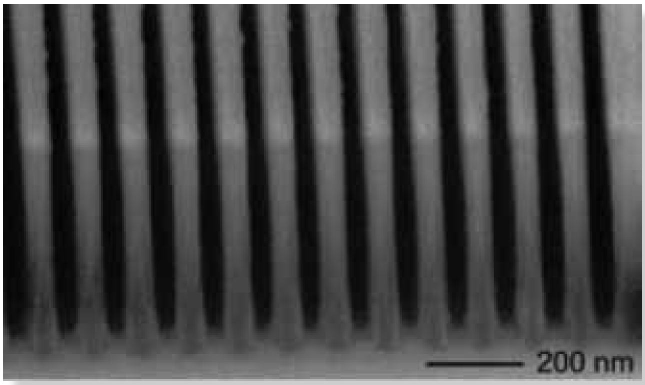
The flexibility of the new Cobra ICP source will help accelerate our capability in nanoscale etching. OIPT is well placed to exploit the gathering nanotechnology revolution, not only with our etching tools but also with our deposition and growth tools. Indeed we are a world leading supplier of such tools to many of the major nanotechnology research facilities and universities in the world. Here we focus on the etching aspect of nanotechnology, where there are major applications in memories, displays, novel semiconductor, optoelectronic and quantum computing devices.

Nanoscale etching is fundamentally difficult for two basic reasons:
1) more difficult transport of neutrals species in and out of the smaller features and 2) increased effects of charging by ions and electrons as sidewalls get closer together. The situation is compounded by the fact that in the design of smaller devices, the lateral shrink is usually greater than the vertical shrink so the aspect ratio increases.

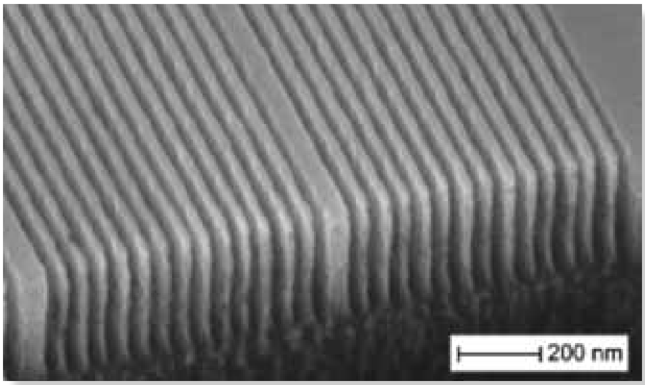
It is the ability of OIPT ICP tools to operate at low pressure yet with high plasma density and low (controllable) DC bias that helps greatly compared to simple RIE. Low pressure improves anisotropy by minimising scattering of species by gas phase collisions.

The latest Cobra source offers further increased flexibility through options of 1) Active spacer: allows independent control of ion distribution and delivers optimised process uniformity across the electrode. 2) Pulsing: ICP Source Pulsing minimises wafer charging, for enhanced high aspect ratio etching. It may also be used for adjustment of ion radical ratios. Bias power pulsing (usually with low frequency power) minimises notching at interfaces with insulators and reduces aspect ratio dependent etching (ARDE).

The white paper referred to below gives many examples nanoscale etching in the specific areas of nano-imprint lithography and photonic crystal holes as well as silicon and other miscellaneous etches. The two examples reproduced here are courtesy of Anders Holmberg, Biomedical and X-Ray Physics, Royal Institute of Technology, Stockholm, Sweden.



O_2 process chemistry (at -100°C) utilising the low temperature capability of the System 100 ICP65 for HAR anisotropic nanoscale polyimide etching. 50-nm half-pitch polyimide-gratings, 500 nm high (AR 10:1).10nm evaporated titanium hard mask. Polyimide etch rate 100nm/min.



Cl_2 process chemistry used in the System 100 ICP65 for high aspect ratio anisotropic nanoscale Ge etching 10nm evaporated titanium hard mask. Ge etch rate 100nm/min. 25-nm half-pitch Ge-grating, 310nm deep (AR 12:1).

Read the full review article Nanoscale Etching in Oxford Instruments ICP Systems in a White Paper authored by Colin Welch.
If you'd like a copy please email: plasma@oxinst.com or look online **www.oxford-instruments.com/plasma**

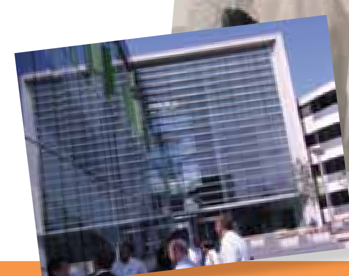
2011 Seminars launched

Building on last year's successful seminar and workshop programme, we will hold similar events in 2011 in conjunction with key research institutes & universities globally. Speakers will come from the host universities and from a number of other institutes and industry. In addition, our process and applications experts will provide their in-depth knowledge of the chosen topic.

June 30th 2011 **Knowledge Creation Partnership – From Funding to Results**
Hosted by the University of Southampton & Oxford Instruments, held at the University of Southampton

July 14-15th 2011 **New Frontiers in Plasma Nanopatterning**
Hosted by the Molecular Foundry, Lawrence Berkeley National Laboratory, CA, USA

October 18th 2011 **Nanoscale Plasma Processing**
Held at CEA-LETI, Grenoble, France



Programmes are available, and for more info about each seminar and/or to register for a place, email: **plasma@oxinst.com**

Nanoelectronics: Growth, Deposition, Etching seminar was hosted by us recently with the prestigious Institute of Semiconductors Chinese Academy of Sciences (IOS CAS) in Beijing, China. The seminar attracted record attendance for an Oxford Instruments' seminar, with a wide variety of talks by invited speakers and Oxford Instruments process experts, followed by a tour of the prestigious IOS Cleanroom.

EVENTS ROUNDUP

Oxford Instruments Plasma Technology will be exhibiting at the following events:

May 9 - 12	**Optifab (optical fabrication event)**	*Rochester, NY, USA*
May 16 - 19	**CS Mantech**	*California, USA*
May 22 - 26	**Compound Semiconductor Week**	*Berlin, Germany*
May 31 - June 3	**EIPBN**	*Las Vegas, USA*
May 31 - June 2	**SEMI Expo CIS**	*Moscow, Russia*
June 5 - 9	**Transducers 2011**	*Beijing, China*
June 14 - 16	**OPTO Taiwan Photonics Expo**	*Taipei, Taiwan*
June 23	**S2K 2011**	*Surrey University, UK*
June 26 - 29	**ALD 2011**	*Cambridge, Mass, USA*
June 30	**Oxford Instruments Seminar**	*Southampton University, UK*

Dedicated Training Department

As part of our ongoing commitment to customers, we've expanded our system maintenance and process training offering, with a new programme and by employing a dedicated Training Officer.

Nick Curtis ensures customers gain an insight into the full range of our etch, deposition and growth systems in order to maximise their performance and process capabilities. Nick joins Oxford Instruments with many years experience in customer and in-house training for a large technical company, so is ideally suited to developing our training programmes.

Our programme of System User and Maintenance Training Courses take place at our Bristol, UK headquarters, in addition to on-site customer training. Courses are available for the **FlexAL** & **OpAL** ALD systems, the full range of **Plasma**Pro plasma etch and deposition systems, and **Ionfab**® ion beam systems.

Working with our trained System Technicians & Engineers, customers learn how to optimise the performance of their system. In addition our Applications Team and Development Scientists conduct Process Training courses in our extensive UK applications laboratories, tailored to individual customer requirements.

"I enjoyed the course and learned a lot about Ion Sources. The knowledge gained about sources should prove extremely valuable."

Michael Hume, University of Alberta, Canada

www.oxford-instruments.com/plasma for more information

Oxford Instruments Plasma Technology

For more information please email:
plasma@oxinst.com

UK
Yatton
Tel: +44 (0)1934 837000

Germany
Wiesbaden
Tel: +49 (0)6122 937 161

Japan
Tokyo
Tel: +81 3 5245 3261

PR China
Beijing
Tel: +86 10 6518 8160/1/2

Shanghai
Tel: +86 21 6132 9688

Singapore
Tel: +65 6337 6848

Taiwan
Tel: +8863 578 8696

US, Canada & Latin America
Concord, MA
TOLLFREE: +1 800 447 4717

Book now for process or maintenance training

For our latest training course dates either email:

plasmacs@oxinst.com

or look on our website

www.oxford-instruments.co.uk/support

www.oxford-instruments.com

OXFORD INSTRUMENTS

The Business of Science®