Atomic Layer Etching

Innovative solutions for etching to the atomic layer

OXFORD INSTRUMENTS

What is Atomic Layer Etching?

Atomic Layer Etching (ALE) is a technique designed to allow the accurate removal of one atomic layer at a time; a level of control unachievable using conventional etching.

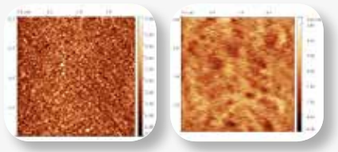
As layers become thinner to enable the next generation semiconductor devices there is a need for ever more precise process control to create and manipulate these layers**.** The PlasmaPro100 ALE delivers this through specialised hardware including:

- **Precise control** of gas dose
- **Excellent repeatability** of low power RF delivery
- **Rapid switching** enabled by fast PLC

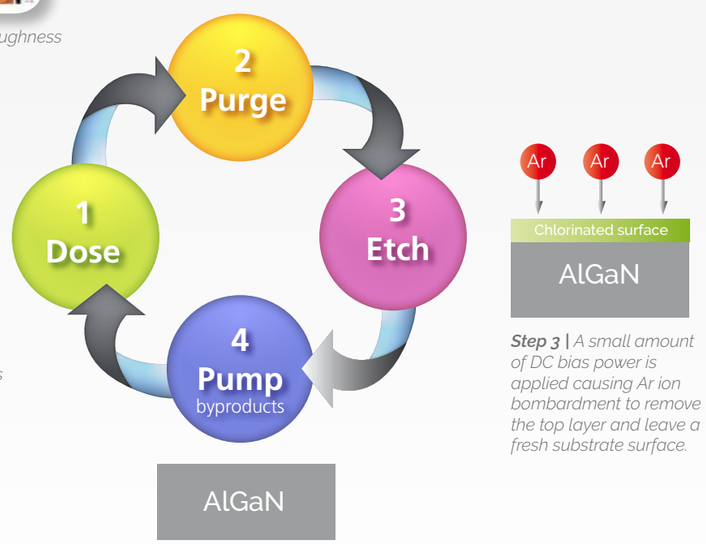
All these combine to enable etching with accuracy at the atomic scale.

Benefits of ALE

- **Smooth etch** surfaces
- **High selectivity** to layers including some materials not possible using a conventional plasma etch
- **Low damage**
- **Excellent uniformity**
- **Minimal aspect ratio** dependence
- **High accuracy** of etched depth
- Ideal for **nanoscale layer removal**
- Possibility of **single atomic layer etch** (e.g. for 2D materials)



AFM images show AlGaN surface roughness reduced by 0.3nm within 30 cycles



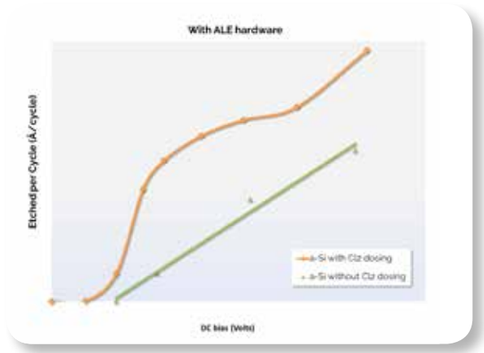
***Step 1** | Chamber is given a short dose with a chemically reactive species (Cl_2 for GaN, AlGaN or Si). This forms a layer on the substrate surface*

***Step 2** | Excess Cl_2 is pumped away to leave just a layer on the substrate surface*

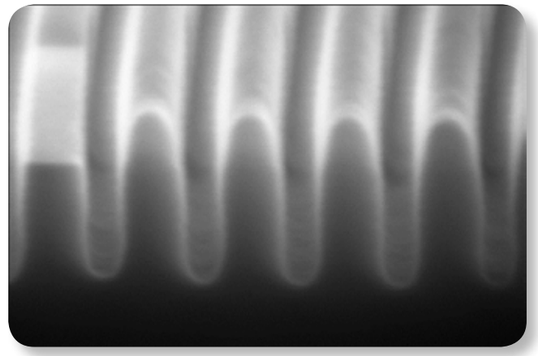
***Step 3** | A small amount of DC bias power is applied causing Ar ion bombardment to remove the top layer and leave a fresh substrate surface.*

***Step 4** | Pump out step to remove all by-products from the chamber before a fresh dose of Cl_2 is introduced*

ALE Process



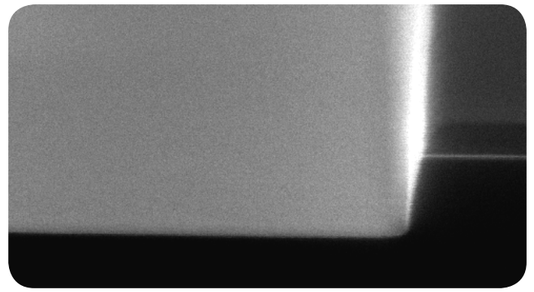
Graph showing true ALE plateau when etching a-Si, the precise control of the RF power is essential to achieve repeatable ALE.



25nm wide Si trenches etched to 110nm depth, 150cycles; HSQ mask still in place

Wide range of materials

Material Etched	Dose Gas	Etch Gas
Si or a-Si	Cl_2	Ar
MoS_2	Cl_2	Ar
SiO_2	CHF_3 or C_4F_8	Ar or O_2
AlGaN/GaN	Cl_2, BCl_3	Ar
AlGaN/GaN	N_2O	BCl_3



Smooth Si etch surface after 150 ALE cycles

Global Service and Support

Worldwide Service and Support

Oxford Instruments is committed to supporting our customers' success. We recognise that this requires world class products complemented by world class support. Our global service force is backed by regional offices, offering rapid support wherever you are in the world.

We can provide:

- Flexible service agreements to meet your needs
- Tailored system training courses
- System upgrades and refurbishments
- Immediate access to genuine spare parts and accessories

visit **plasma.oxinst.com** for more information

For further information about our tools, please contact your local Oxford Instruments Plasma Technology office

For more information please email:
plasma@oxinst.com

UK
Yatton
Tel: +44 (0) 1934 837000

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

India
Mumbai
Tel: +91 22 4253 5100

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: +886 3 5788696

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

OXFORD INSTRUMENTS