Oxford Instruments Severn Beach: Driving advances in compound semiconductors

10 July 2024

Richard Tyson, CEO

Matt Kelly, Managing Director, Plasma Technology

An introduction to a **world-class facility** set to address **structural growth** in the **compound semiconductor** market

What we'll cover today:

- **Introduction –** Richard Tyson, CEO
- **Compound semiconductor: the opportunity** – Matt Kelly, Managing Director, Plasma Technology
- **Your questions**

- **Lunch**

- **Site tour and demonstrations**

A clear plan for value creation

	Imaging & Analysis Good to great		Advanced Technologies Fix, improve and grow	
Capabilities	Leading range of microscopy, scientific cameras, spectroscopy and associated analytical tools and software		Compound semiconductor fabrication equipment Cryogenic and magnet technology for quantum and advanced materials research	
The opportunity*	**Current** c.£328m revenue | 22-24% AOP margin recent history	**Medium-term** 23-25% AOP margin*	**Current** c.£142m revenue | 0-4% AOP margin recent history	**Medium-term** 10-12% AOP margin*
The plan	**Excellent business and good track record** • Share best practice across businesses and regions • Standardise processes • Improve operating efficiency		**Focus business on critical actions** • Extract full growth and margin potential from compound semiconductor and new facility • Fix and improve Quantum business • Improve operational performance and efficiency	

* At constant currency

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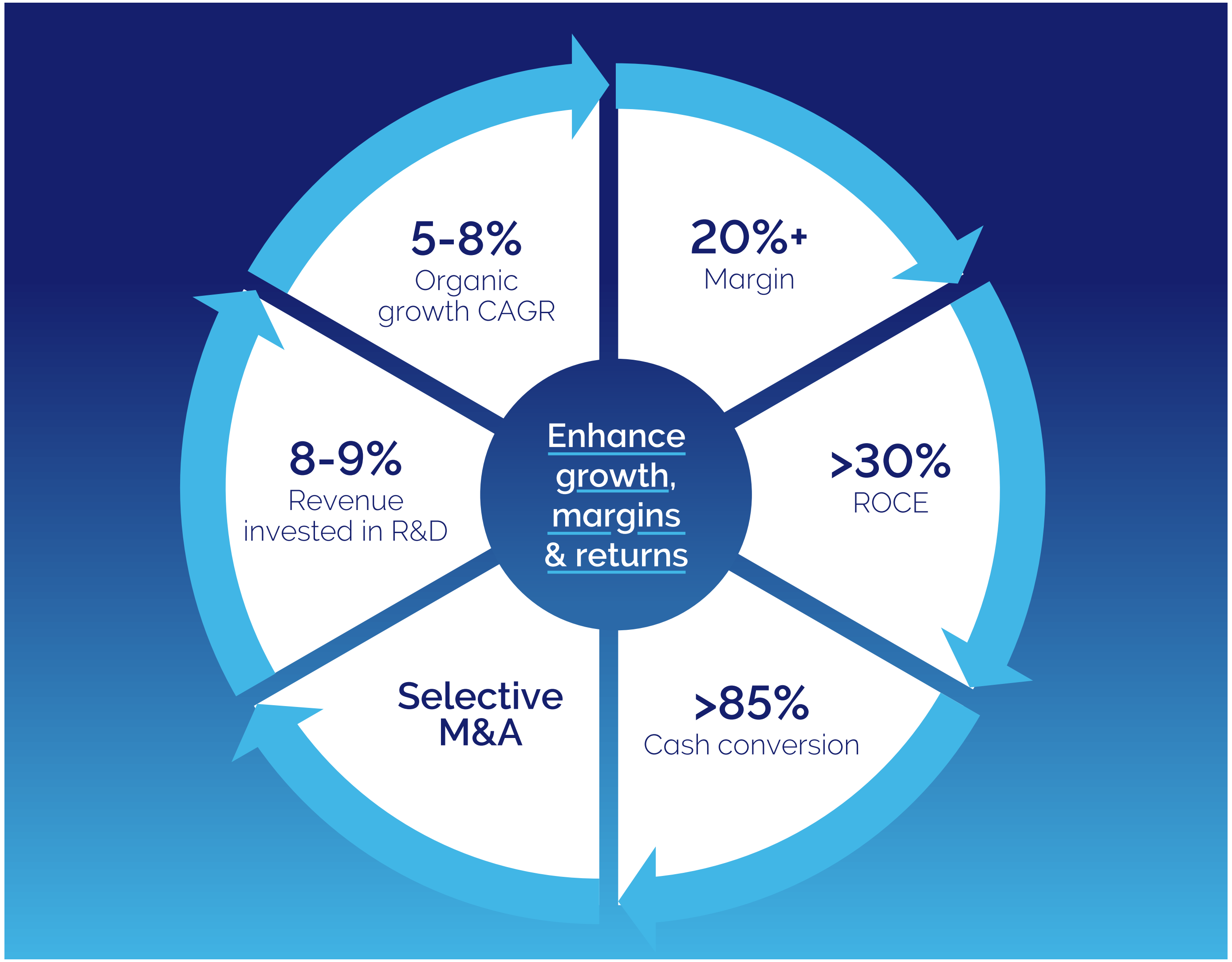
A refreshed strategy: a new lens on Oxford Instruments

- New simplified divisional structure
- Three main markets: materials analysis, semiconductors and healthcare & life science
- Major operational improvement programme
- Step change in our customer performance
- Continue significant investment in technology



Three key structural growth end markets

4–7% Market growth pa*

£1.2bn Market size*

43% % Group revenue

Structural drivers
- Supports advanced material development and sustainability progress
- Improved performance from finite resources

6–9% Market growth pa*

£1.5bn Market size*

27% % Group revenue

Structural drivers
- Enabling development of new compound semiconductors
- Growth in bandwidth, connectivity and faster devices
- Power efficiency and green economy

8–12% Market growth pa*

£2.0bn Market size*

19% % Group revenue

Structural drivers
- Improved treatments & vaccines; reduced cost of development
- Personalised medicine & therapies
- Ageing population

* Market growth opportunities refer to applied R&D and production and testing; market size = our addressable market annually
Source: SDi/Gartner

c.90% of Group revenues in **three key markets** exhibiting strong structural growth
Other 10% includes quantum: uncertain timing and technology, high potential

Positioned in structural growth markets

Three key structural growth end markets

Market growth pa*	Market size*	% Group revenue
4–7%	£1.2bn	43%

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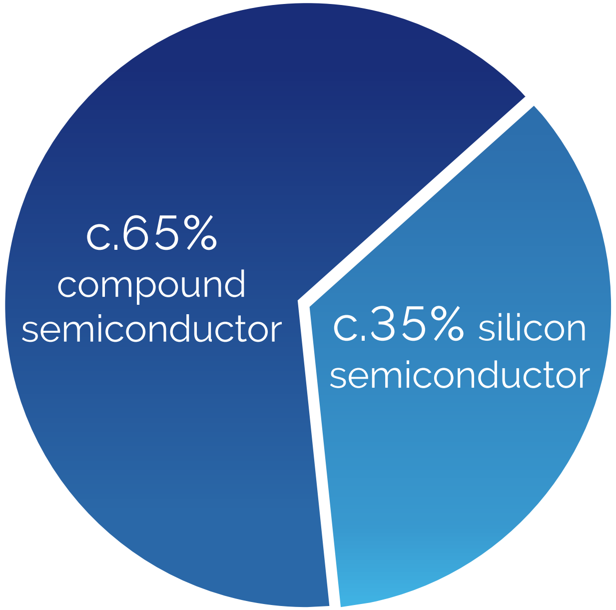
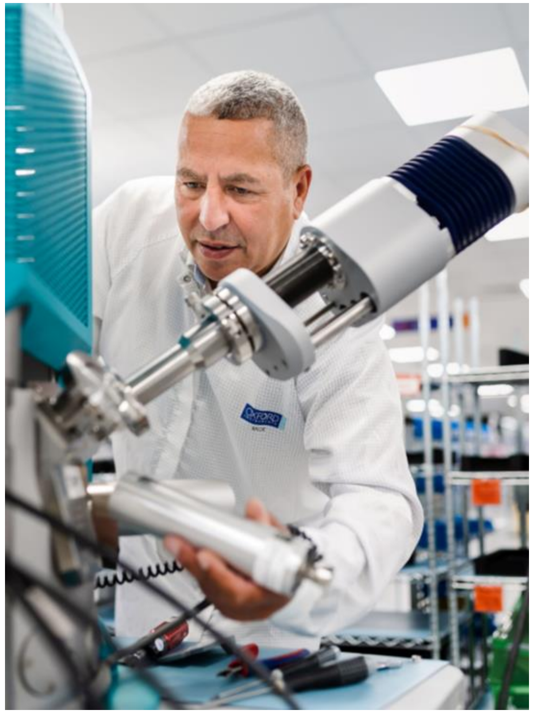
Advanced Technologies
Large capital equipment for compound semiconductor fabrication



Imaging & Analysis
Microscopy and analysis tools



% of Group semiconductor revenue

Positioned in structural growth markets

Compound semiconductors

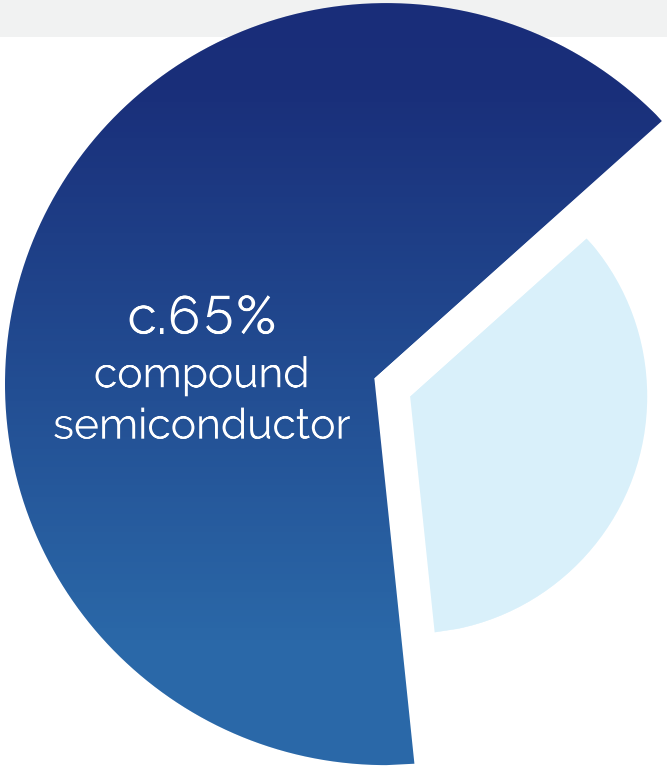
10%+ Market growth pa*

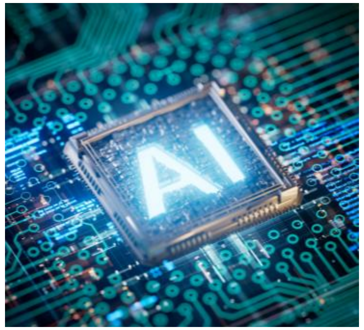
£1bn Market size*

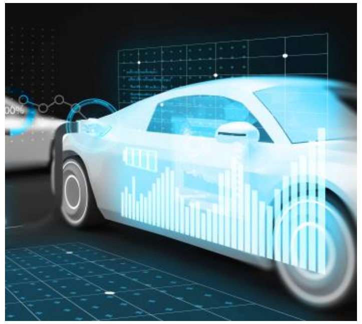
c.20% % Group revenue

Structural drivers

- Generative AI
- Future datacentres
- Power electronics
- Augmented reality and micro-LED
- 3D sensing







Compound semiconductors: The opportunity

Matt Kelly, Managing Director, Plasma Technology

From a **pioneer** in a **nascent field** of technology to a **global installed base** and a **world-class facility**

Founded in 1980 to address the high-end plasma physics research market… acquired by Oxford Instruments in 1990

Business scales and transitions to attract both academic and commercial customers, reaching a global installed base of more than 3,500 systems

New world-class facility opens at Severn Beach; business reaches £90m revenue

1980

2024

Compound semiconductors: what's the difference?

The **efficiency** and **flexibility** of compound materials **enables applications not possible** with **silicon**

- Higher energy efficiency
- Higher power
- Wider temperature range
- Greater optoelectronic properties

Higher growth market with **10%+** CAGR

Silicon carbide

More efficient power conversion
in electric vehicles & renewable energy

Gallium nitride

5G/6G base stations, power-efficient consumer electronics and micro-LED display

Gallium arsenide

3D sensing arrays and short-range fibre connections in datacentres

Indium phosphide & gallium arsenide

Increased optical fibre data bandwidth for next gen lasers and receivers

Rapidly growing range of compound semiconductor applications

Plasma Technology involved from **early-stage research** and **corporate R&D** through to **volume manufacturing**

Corporate R&D → **Growth/ Consumer adoption**

	FY24	FY25	FY26	FY27	FY28	FY29	FY30
Silicon carbide power electronics		Electric vehicles		Renewable energy conversion		Battery driven power electronics	
Gallium nitride power electronics and RF	5G; USB-C fast charger			Electric vehicles	6G network	Renewable energy conversion	Autonomous vehicles; 6G smartphone
Indium phosphide and gallium arsenide datacom laser	3D sensors/ Face ID	Datacentre; Cloud		AI drives hyperscale datacentre	Machine learning	Secure comms	Autonomous vehicles; Smart traffic
Gallium nitride and gallium arsenide micro-LED				AR headset	Smart watch display		Smartphone; Curved display; TV

Rapidly growing range of compound semiconductor applications

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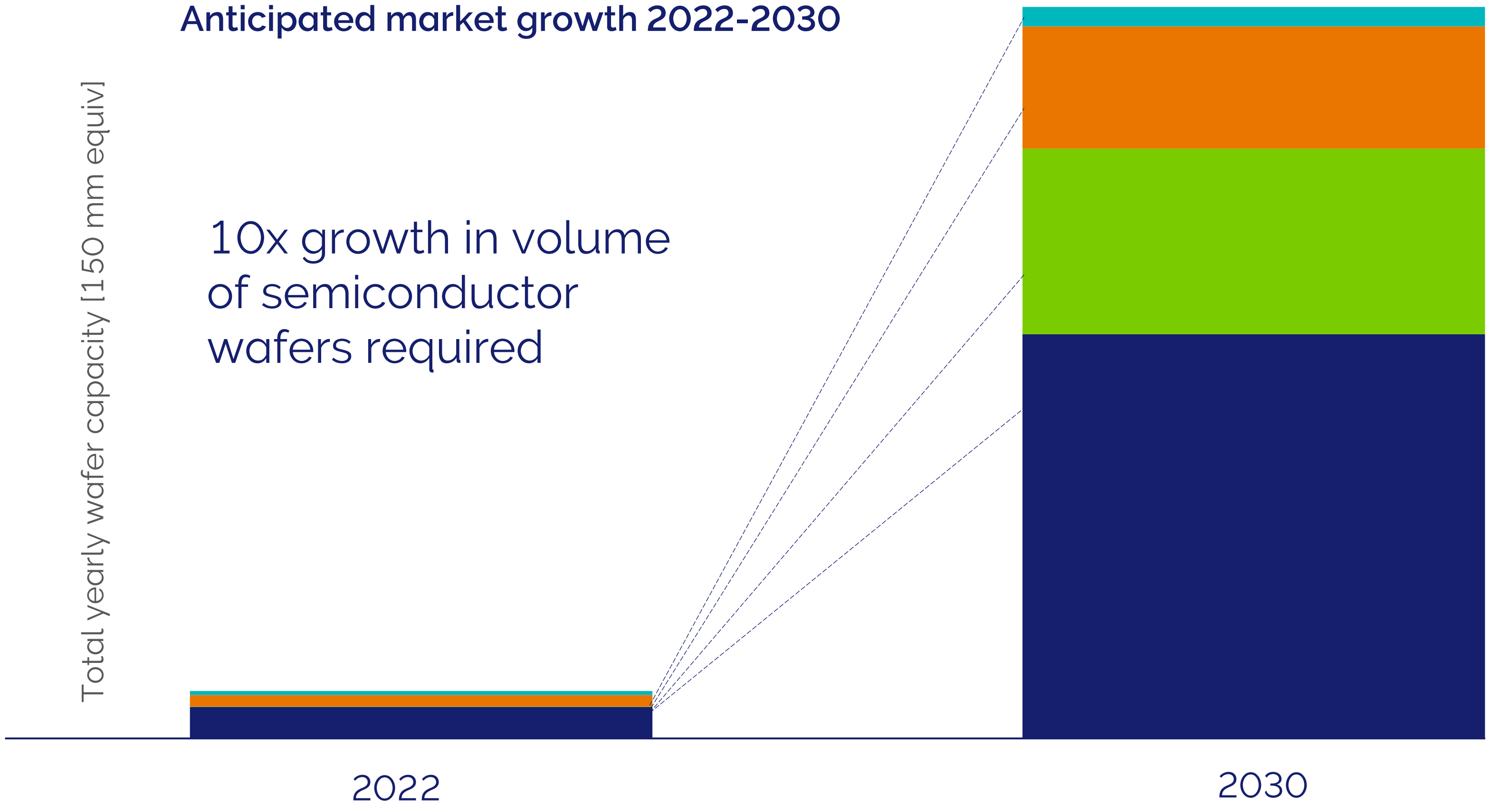
The journey to **volume manufacturing**: from **niche** to **mainstream**

Plasma Technology scaling up in line with market growth in hardware, process and fab integration

- Indium phosphide/ Gallium arsenide datacom laser
- Silicon carbide power electronics
- Gallium nitride and gallium arsenide Micro LED
- Gallium nitride power electronics and RF



Source: Oxford Instruments wafer model (2023), Yole Development, Gartner capital market reports and Ovum for datacom

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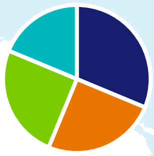
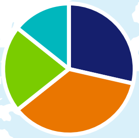
Governments globally committing to **significant national programmes**

Chart shows **spending commitments** with date announced



Americas
USA: $280 bn CHIPS Act (2022)
Canada: $240m (2022); $60m (2024)



EMEA
EU: €43bn (2023 European Chips Act)
Germany: €20bn (2023)
Italy: €10bn (2024)
Spain: €12bn (2022)
UK: £200m (2023)

China
$47.5bn (Phase 3: 2024)

Japan
¥3.9 trn (2021-23)

Rest of South East Asia
South Korea: $19bn (2024)
Singapore: $18bn (2021-25)
Malaysia: $5.3bn (2024)

Compound markets are forecast to grow significantly, in particular outside China, driven by:

- Substantial volume of global funding, tax incentives offered by governments to drive catch up.
- Drive for localisation of supply chain to minimise exposure to regional risks
- Attractiveness of high margin ‘technology-driven’ applications.

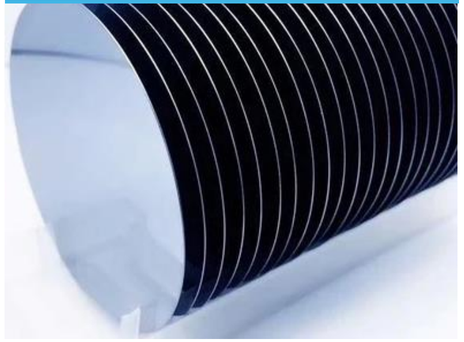
Gallium nitride power electronics & RF | Silicon carbide power electronics | 3D sensors and data communications | Augmented reality and micro-LED

Plasma Technology: playing a critical part in the compound semi value chain

Boule growth

Boules are grown…

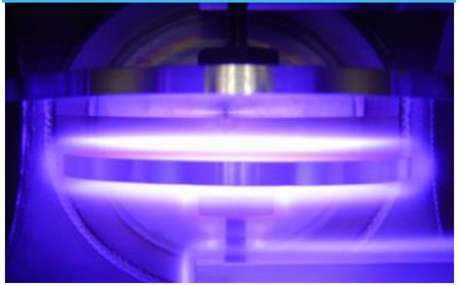
Wafering



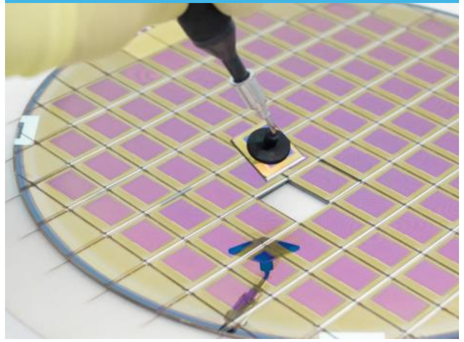
…then sliced into wafers…

Front end of line processing

Layers are etched and deposited on the wafer using process gases. Plasma Technology operates in this part of the value chain

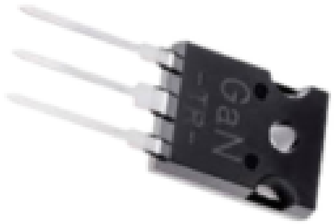


Back end of line processing



Wafers are diced into individual chips…

System level



… and incorporated into the final packaged device

← Front end of line processing represents c. 65% of capital expenditure in compound semiconductor market

A portfolio of targeted technologies at varying stages of adoption

Enabling increased bandwidth in data communications using indium phosphide

Strong footprint in an **established market**

Driving improved power efficiency with gallium nitride devices

Growing footprint in a **new market**

Enabling advances in augmented reality and micro-LED using atomic layer etch and deposition

Strong potential in an **R&D phase technology**

Silicon carbide for **power electronics**

High thermal conductivity and maximum current density enable:

- Improved efficiency
- Smaller size
- Lower weight
- Lower temperature
- Faster switching

Power supplies

Solar

EVs

Energy storage

Disruptive **Plasma Polish** technique has potential to support **silicon carbide market scaling,** enabling volume production of more **high-quality wafers** at a **lower cost**

- Alternative to standard chemical polish process currently in advanced feasibility studies
- Removes surface damage
- Reduces polishing cost
- Reduces environmental impact

Plasma Technology: a leader in compound semi

Why we win: superior technology and **capabilities** in **carefully targeted** and **specialist growth markets**

- Vast amount of experience and know-how built up over 40 years
- Unique breadth of technology in our part of the value chain
- Unparalleled access to metrology as part of the wider Oxford Instruments offering

Enabling USB-C fast charging

A **$35** reduction in wafer cost for a US customer

30% market share achieved in smartphone fast charging

Future GaN applications

Working with leader in automotive supply chain on 350 KWh+ EV chargers to reduce charging time:

30 mins to **<10 mins**

ROHM SEMICONDUCTOR

Enabling our customers to achieve higher performance, better quality and a higher wafer yield at a lower cost

The compound semiconductor ecosystem

#1 supplier to **major semiconductor universities**

Increasing installed base for **next generation** compound semi **production** applications

Enabling semiconductor **manufacturing yields** and cost reductions to support scaling

Academic R&D: 45% Plasma Technology revenue

Corporate R&D: 15% Plasma Technology revenue

Compound semiconductor production: 40% Plasma Technology revenue

Note: Graphic does not necessarily represent OI customers.

Where we've come from

Legacy Yatton site: **no longer compatible** with customers' needs or the needs of the business

- Site has supported revenue growth from £10m to £70m, but layout not optimised and facility had reached end of life
- Credibility with large market players was compromised

Today: a state-of-the-art compound semiconductor equipment facility fit for the future




New Severn Beach site **reinforces right to play** in **volume production**

Tripling potential capacity versus legacy site	Application lab will accelerate R&D and validation capabilities	Extensive customer suite facilitates on-site testing and collaboration	World-class cleanroom to be operational Q4 24/25

From equipment maker to fully integrated high-volume production partner

2000-2010
Transactional relationship

2010-early 2020s
Adding extra value

Today-2030 and beyond
Fully integrated partner

Our **world-class clean room** and **applications lab and metrology capabilities** are the key to becoming **an indispensable partner** to our customers

Transition to value stream management	Standardised product range and removal of 'specials'	Moving people rather than equipment in build and test phase
Visual management introduced	More modular design enables quality control and stronger supply chain integration	Team engagement and resourcing for future via introduction of talent academy

Driving efficiency and lean principles

15% productivity improvement to date on Plasma Pro 100:

- Production time reduced by **40 hours** to **220 hours**

Target: **180 hours**

Targeted go-to-market strategy for sales and service

Ramping up to **maximise growth** and address the needs of **high-volume manufacturing**

Focused segment team

Optimising our footprint in Japan and SE Asia

Total **pipeline** of opportunity for Plasma Technology **doubled** from **£250m to £500m** in last three years

Investment in service infrastructure

Channel partnerships

c. 17% Plasma Technology revenue generated from service today, with scope to grow to **20%** and beyond

Our strategy for growth

Market & customer focus	Operational excellence	Value solution partner	Talent and culture
Capitalise on potential within our target markets moving from **low volume** to **volume** manufacturing	**Streamline R&D** and **manufacturing process** towards operational excellence	**Extend uptime** and **develop enhanced service offerings**	**Developing** the **team** and **culture** for the **volume manufacturing** journey

Compounding growth to leverage facility and drive profitability

	Building on our growth track record		The journey to high-volume manufacturing	
The opportunity	Doubled revenues in the last 5 years	High single digit margins	Double revenues again - compounding >10% growth	Medium term mid-teens+ margins
The market	From a nascent market to coming of age Moving from academic to commercial applications		A high growth market with clear structural drivers Increasing adoption for diversified commercial applications	
Facilities	**Capacity constrained, lower specification facilities** **Enabled a substantial installed base but didn't support volume production**		**World-class facilities triple capacity for growth** **Operational leverage thereafter as we drive productivity and efficiency**	

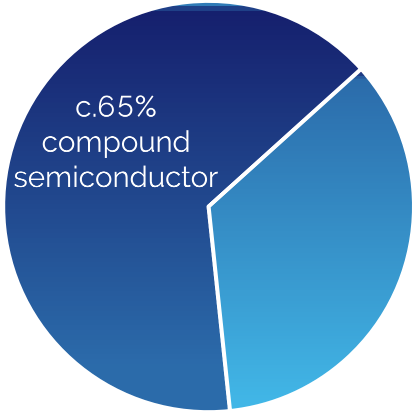
A clear plan for revenue and margin enhancement as we enable a structural growth market

Well-positioned in the 10% + compound semiconductor growth market

A key enabler of next generation chips and market adoption

Competitive advantages enhanced by new world-class facility

A clear plan to grow both revenue and margin



% of Group semiconductor revenue (largest part of Advanced Technologies)

> 10%
revenue CAGR

Mid-teens +
Medium-term margin

To **accelerate** the **breakthroughs** that create a **brighter future for our world.**

Our technology and scientific expertise enables our customers to discover and bring to market exciting new advances that drive human progress.

Appendix

Glossary of terms – basics

Semiconductor
Generic name for transistors and integrated circuits that can control the flow of electric signals.

Transistor
Named for its electrical characteristic of "transfer resistance," these are the current switches that are the essential building blocks of integrated circuits.

Integrated device
Components in a circuit that combine to perform one or more functions (e.g. a laser with a transmitter and receiver)

Discrete device
A device that performs a single function found in electrical circuits (e.g. a high-voltage switch)

Die
One individual integrated chip built onto a wafer.

Diode
An electronic device that restricts current flow chiefly to one direction.

MicroLED (µLED)
A few micron-sized type of light emitting diode (LED) that are packed incredibly densely together into small high-definition screens (e.g. Apple watch)

Augmented (AR) or virtual (VR) reality
AR – technology that overlays images into the natural environment that the user is in. VR – an alternate computer-generated reality that the user enters using a headset that removes the sense of them still being in the natural environment

Glossary of terms – device-related

Fabrication
The process of creating devices, carried out in a fab, or many fabs.

Epitaxy
After substrate fabrication, the next step is often to deposit a layer of material (an epitaxy or 'epi' layer) with critical material properties that makes the device function as designed.

Passivation
A layer of insulating material deposited on a wafer to stabilize and protect the surface against moisture, contamination, and mechanical damage.

Dielectric
Dielectrics are layers used within the device to mask against the diffusion of dopants and provide tuneable electrical isolation between material layers

Doping
The combination of a chemical impurity into the crystal structure of a semiconductor to modify its electrical properties.

Lithography
The transfer of a pattern or image from mask to wafer; "photolithography" uses light to affect the transfer.

Deposition
The procedure in which films of insulating and/or conducting materials are deposited onto a wafer.

Etch
Chemically removing material from the wafer, sometime using a mask to selectively remove areas of material while leaving the rest untouched.

Ion beam
Primarily a high physical and low chemical form of etch and deposition that allows material to be removed or added at angles to the surface of the wafer

ALD (Atomic Layer Deposition)
Thin films are grown in cycles where the surface is exposed to various gas-phase species in alternating doses, and isolated by evacuation or inert purging. Only a single layer of precursor absorbs the surface.

ALE (Atomic Layer Etching)
A precise process that etches single atomic layers of a material, which ensures extremely low damage and high levels of accuracy.

PECVD (Plasma Enhanced Chemical Vapour Deposition)
Process of applying a thin film to a substrate using chemically reactive gasses and plasma.

Cleanroom
A low or dust free area to reduce contamination getting onto the wafer surface and into the devices

Cluster
An array of processing chambers around a single load lock chamber housing a substrate handling robot.

Load lock
A sealable chamber adjacent to the processing chamber, which allows the specimen to be loaded onto the substrate table without having to vent the processing chamber.

Boule and wafer (a.k.a substrate)
Boules are manufactured cylindrical crystal blocks that have been grown from materials like silicon, silicon carbide, gallium arsenide or indium phosphide. Boules are sliced horizontally to form crystal discs known as wafers or substrates, that are the starting material for devices to be fabricated on the surface

Substrate
The underlying material on which a microelectronic device is built.

Precursor
Chemical compound which reacts with a second reactant to form another related material.

Process gas
Specific types of gas that are fed into the chamber and ignited with radio frequency energy to create a bright chemically reactive plasma gas

Plasma
A mix of electrons, positive ions and neutral gas particles created between electrodes within which the various etching or deposition processes take place.

Silicon carbide
The main compound material for advanced power applications in the high voltage range.

Gallium nitride
The main compound material for advanced power applications in the low to medium (maybe high voltage in future) voltage range.

Gallium arsenide
The main compound material for creating the types of laser used in facial recognition and some short-range data transfer.

Indium phosphide
The main compound material for creating the types of laser used in long-range data transfer and long-distance environment sensing in automotive applications.

2D TMDs (Two-Dimensional Transition Metal Dichalcogenides)
Atomically thin semiconductors that intrinsically have a 2D nature. Their chemical formula is written as MX_2, where M is a transition metal (such as Molybdenum or Tungsten), and X is a chalcogen (such as Sulphur or Selenium).

Band gap and wide band gap (WBG)
In electronics, electrons in atoms are manipulated to move from their default valance band to the conduction band, to make the materials do something useful in the circuit like emit light or act as a switch. Materials with electrons that are easily manipulated to move, like silicon, are narrow band gap, and advanced materials such as silicon carbide and gallium nitride, have a wide band gap. Wide band gap materials are harder to produce, but are much more efficient, effective and ideally suited to advanced electronic devices.