

## Compound Semiconductor Hub for a Sustainable Future



Welcome to the CS Hub June Newsletter. You may have noticed that we have changed our long name, having been funded to continue research and innovation in the CS manufacturing space. Our vision is to establish the UK as the primary global research and manufacturing hub for Compound Semiconductor (CS) Technologies, expanding and extending the CS Cluster that our previous EPSRC Manufacturing Hub initiated. The CS

Cluster in South Wales currently contributes more than £300M in GVA to the Welsh Economy and provides more than 2,600 high value jobs in the region. This figure is set to increase to 5,000 jobs over the next five years through a combination of attracting new start-ups and inward investment, and this requires a vital research magnet at the heart of the Cluster. The CS Hub will provide this and create and expand UK wide excellence and impact in CS by a) delivering a scientific lead, b) developing sustainable processes and c) combining and connecting UK research excellence with the best translational facilities. The Hub will work with companies and centres of excellence across the UK to support the whole UK CS industry and industry users of CS. The combined activity will provide a path from enabling fundamental research through wafer, device and integrated chip manufacturing research into prototyping, reliability testing and system qualification at the CS Catapult and partner companies; to create the most innovative products and the most sustainable manufacturing processes.

### Cardiff University succesful in sercuring bid for EPSRC sustainable future for compound semiconductor manufacturing hub

We are pleased to officially announce that the CS Hub has successfully secured one of the five new hubs dedicated to tackling the challenge of commercialising early-stage research within critical sectors of manufacturing by reducing waste, finding alternatives to expensive or environmentally damaging materials, and speeding up processes.

The Semiconductor Manufacturing Hub for a Sustainable future will aim to capitalise on the huge opportunity of compound semiconductor manufacturing identified in the UK's national semiconductor strategy. Researchers will develop energy-efficient opto-electronics for use in key emerging technologies such as quantum. They will expand on the environmental benefits of compound semiconductors by creating new devices such as mercury-free 'night vision' mid-infrared detector arrays and devices that both communicate and illuminate based on integrated transistors and LEDs.



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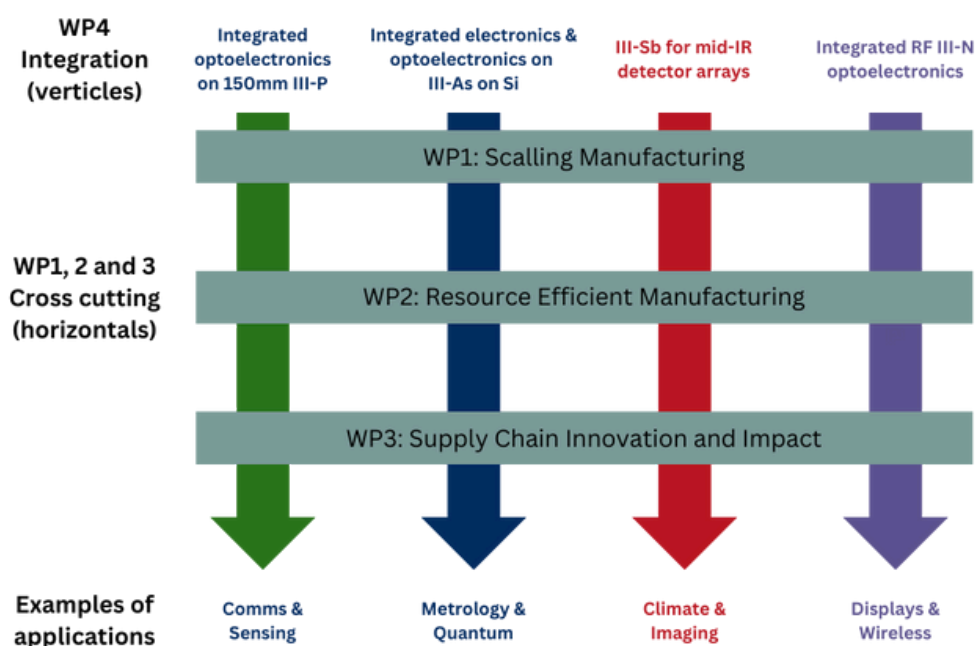


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Compound Semiconductors represent a pivotal technology that underpins modern society, revolutionising energy utilisation in applications like LED lighting and power electronics for electric vehicles. Semiconductors are instrumental in advancing technologies such as the 6G network, autonomous vehicle sensors, the Internet of Things, satellite communications, quantum technology implementation, and novel imaging techniques. In essence, these technologies drive our interconnected world, bolster health, ensure security, and safeguard the environment. Acknowledged by the UK Government, there is a critical juncture to elevate Compound Semiconductor manufacturing to fortify the UK's manufacturing prowess. The UK is uniquely positioned to assume a prominent global role in various essential CS supply chains encompassing communication, mobility, net-zero initiatives, quantum technologies, and sensing applications. The scale of the Hub allows for thorough research to identify viable technologies for manufacturing efficiently. Our sustainable CS Hub is designed to achieve four interconnected objectives that align with Work Packages (WPs) 1-4:

1. Enhancing manufacturing scalability by increasing wafer size and yield for diverse materials (e.g., III-As, -N, -P) and various device types to ensure cost-effective, widespread technologies.
2. Ensuring the UK's research prowess in CSs translates into manufacturable and resource-efficient methodologies, enabling the UK to capitalize on the expansive opportunities offered by CSs.
3. Repatriating and linking UK-based CS manufacturing supply chains to reshore production, stimulate innovation, facilitate holistic solutions, and alter researchers' approaches to amplify the impact of their research.
4. Innovating with integrated functionality and materials to leverage the optimal material combinations for innovative, functional solutions.



Key scientific advancements in various domains, such as the development of mechanisms facilitating InP growth on Silicon-on-Insulator, play a vital role in guiding strategic decisions related to optimal manufacturing approaches. This includes evaluating the advantages of such methods over conventional practices involving 150mm InP substrates. Contributions from scientific research, like mechanisms for substrate reusability and environmentally sustainable etching formulas ensuring consistent, high-quality results across large substrate surfaces, are pivotal in informing these decisions. The primary aim is to maximise output, enhance performance, and minimise environmental impact in all manufacturing processes.

Through rigorous and methodical research efforts, the CS Hub assists organisations in gaining a competitive edge in product development, fostering collaboration within manufacturing supply chains, and positioning the UK as a key player in the field. Noteworthy is the identification by industry partners of specific research challenges, both immediate and long-term, that impede progress, underscoring their readiness to engage in collaborative efforts. These challenges have been integrated into a comprehensive roadmap addressing pressing and strategic inquiries.

## In Focus: *Work Package WP1, Scaling manufacturing*

the previous Hub took whole wafer VCSEL epitaxy, fabrication and characterisation from 100mm to 150mm scale and enabled the development of a new 200mm product for a UK company. Now, due to demand, we need to address a much wider range of important device types and materials that are more difficult to scale. Research challenges include: creating designs that are more tolerant to manufacturing variations that occur in epitaxy and fabrication; inventing fabrication approaches that are more uniform, creating on-wafer and in-line characterisation for parameters that are more difficult to access, part-way through the manufacturing process. Key strands of work include: i) lasers and optoelectronic integrated circuits scaling from 75 and 100mm to 150mm, as optical quality 150mm InP substrates become available, to challenge uniformity of etching of a non-volatile material at large area; ii) 1300nm emitting Quantum Dot on 150 and 200mm GaAs to challenge complex, fast turnaround characterisation across full wafer and to provide feedback on epitaxial non-uniformities; iii) RF transistors and MMICs on 200mm GaN on Si and 150mm GaN on SiC, to challenge fast full-wafer lithography and alignment of gates and larger features and subsequent fabrication, using the new fast e-beam and projection lithography installed at ICS; and iv) growth of all CS types on silicon, where the challenges are defect mitigation and handling stress. QT (quantum technology) has created the need for v) a factor 10 improvement in parameter tolerance in some components, e.g. laser wavelength for atomic clocks, and in manufacturing uniformity, significant challenges even at small wafer size. Highly reproducible, precision manufacturing processes are required now to underpin a practical UK quantum industry and enable impact for the past and current investments in quantum technology.



## Spotlight on : *University of Cambridge*

We are delighted to announce the University of Cambridge as a new addition to our network of hub spoke universities (alongside University of Manchester, University of Sheffield and University College London).

Overseen by WP lead Prof Rachel Oliver, Director of the Cambridge Centre for Gallium Nitride, Cambridge will bring the new capability of 200mm GaN growth, which we hope to demonstrate and develop for a number of device types. The Cambridge centre for Gallium Nitride conducts world leading research into nitride based III-V semiconductors, concentrating the growth and characterisation of gallium nitride based materials to a single site, allowing rapid feedback between the two fields. They are one of a small number of places in the world to have, in close proximity and on the same site, gallium nitride growth equipment, extensive advanced electron microscopy characterisation facilities, advanced X-ray diffraction characterisation facilities, atomic force microscopy, photoluminescence (PL) for measuring optical properties, Hall effect equipment for measuring electrical properties, and basic theory for understanding in detail physical properties.



## Cardiff University will lead one of 65 new UK centres for doctoral training (CDT) established to support research in areas of national importance

The UK's biggest-ever investment in engineering and physical sciences doctoral skills was announced by Science, Innovation and Technology Secretary Michelle Donelan. The CDT in Compound Semiconductor Manufacturing led by Cardiff University will continue to offer a unique programme that provides a holistic understanding of the entire manufacturing process as well as expertise in at least one stage. We believe that this approach is key to developing you as a future leader of compound semiconductor manufacturing, whether you choose to pursue a career in industry or academia or both.

Professor Peter Smowton, who will lead the CDT said *"The next phase of our CDT will provide the step change in CS manufacturing necessary to achieve the next generation technologies and also focus on embedding energy and resource efficiency into these manufacturing processes."*



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## Save the Date: *Industry open days - 16th July and 19th September*

Alongside the Compound Semiconductors Manufacturing CDT and the Institute of Compound Semiconductors, we extend an invitation to a briefing and networking event designed to illustrate how these programs can assist you in achieving your objectives.

Scheduled from 10:30 a.m. to 3:15 p.m., this event aims to facilitate discussions on mutual areas of interest, featuring lunch and ample networking opportunities. The venue for this event is Cardiff University's Innovation Park on Maindy Road in Cardiff, housing the Translational Research Hub and the Institute of Compound Semiconductors.

During the event, you will have the chance to see the new 1350 square meter clean room, dedicated characterization space, and back-end processing areas. These cutting-edge facilities enable the Institute for Compound Semiconductors to process wafers up to 8 inches in diameter while expanding their suite of industry-standard services.

To register interest in these events, please contact Andrea Watkins: [watkinsa16@cardiff.ac.uk](mailto:watkinsa16@cardiff.ac.uk)

### The Compound Semiconductor Manufacturing Hub For A Sustainable Future

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