LAUNCHING THE COMPOUND SEMICONDUCTOR APPLICATIONS CATAPULT

We work with Innovate UK
The potential
The UK is well-placed to become the best place in the world to develop new products and services using compound semiconductors. We have world-leading researchers, businesses producing the basic materials and an electronics sector with the products and customers to take advantage of the opportunity. They face significant challenges in adopting this exciting but complex technology. We have identified how we can help them to integrate compound semiconductors into the heart of a new technological revolution in the UK. We must act now to seize this opportunity.

ABOUT US

The Compound Semiconductor Applications Catapult’s purpose is to deliver long-term benefits to the UK economy and accelerate UK economic growth in industries where applying compound semiconductors creates a competitive advantage and enables new products and markets.

OUR VISION IS FOR THE UK TO BECOME A GLOBAL LEADER IN DEVELOPING AND COMMERCIALISING NEW APPLICATIONS FOR COMPOUND SEMICONDUCTORS

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CHAIRMAN’S STATEMENT

When I took up my role as Chairman of the Compound Semiconductor Applications Catapult last year, it was clear that we had a fantastic opportunity ahead of us. I have seen technology drive amazing change across the world. That pace of change shows no sign of letting up and it will continue to revolutionise the way we get about, power our world, communicate with each other and monitor our health. Compound semiconductors – much faster and more efficient than their predecessors – will be at the heart of the devices that power this revolution, generating considerable benefits not only for the UK electronics sector but also for the UK industries that apply them.

Our impressive innovation centre at the heart of a dynamic cluster in South Wales is under development and will soon be opening. Its unique facilities and skills will help companies and researchers overcome the barriers which prevent them growing faster. We will develop satellite sites around the country, further developing the UK’s leadership. We have assembled an expert board with a wealth of experience and are collaborating widely, connecting the entire food chain of the compound semiconductor industry in the UK. We are also helping companies realise the remarkable benefits of compound semiconductors in their products and systems.

As we embark on our journey, there’s excitement and great anticipation. I am thankful to all the stakeholders who have supported us as we have developed our strategy and implementation plans. Please, come and work with us to build a new industry.
CEO SUMMARY

I’m delighted to be launching the Compound Semiconductor Applications Catapult at this exciting time. The transformative potential for compound semiconductors to meet the challenges of the future has never been higher, the UK has substantial capabilities to build on and a critical mass of people and investment have coalesced around the need for action.

Stephen Doran,
CEO,
Compound Semiconductor Applications Catapult

We have worked with more than 150 businesses to develop our strategy and plans for the Catapult. They have told us of the challenges which prevent the greater adoption of compound semiconductors. We’ve heard that:

• Companies have limited access to the specialist expertise, tools and test facilities they need to validate their prototype products.
• The UK has a supply chain that is highly fragmented. Companies are reluctant to scale up unless there is a proven market, and users will not develop products with unproven technology.
• There is a lack of awareness among companies of how compound semiconductors could transform their products.

Our strategy has been developed to respond to these challenges:

• We will open an impressive innovation centre within the world’s premier compound semiconductor cluster in South Wales. Housing a design studio, laboratories and test facilities, supported by simulation and modelling tools and advanced capabilities, it will help companies to accelerate the development of new products using compound semiconductors.
• Evaluation modules allow companies to more rapidly prototype systems using UK sourced semiconductors and components, where we can. We will be designing and manufacturing a series of these across different application areas and making them widely available.
• We will run a series of challenge programmes, identifying how compound semiconductors can address global challenges and helping SMEs to supply relevant products to companies with access to large and growing markets.

Our strategy has been widely endorsed. We’ve made great progress in a short time creating detailed plans for all areas of the business and we are growing fast.

The most exciting part comes next: we want to work with you to make a real difference to your business, to the UK compound semiconductor sector and to the wider UK economy. Collaboration across the industry is key. Whether you want to work collaboratively with the Catapult and a number of partners or directly with us we want to support your aspirations and make compound semiconductor-based technological solutions a reality.

We have identified the need for an independent centre of expertise that can join researchers and the compound semiconductor supply industry with those businesses that can gain the most from using compound semiconductors in systems and devices.

www.csa.catapult.org.uk
Semiconductors are at the heart of almost all modern electronic devices. Silicon, the most common, has widespread commercial applications and is readily available. Compound semiconductors combine two or more elements to create capabilities that cannot be achieved with conventional silicon devices, delivering performance improvements in power, speed, latency and signal quality. This makes them ideal to use in areas such as energy efficiency, electrified and autonomous vehicles, mobile services, new smart sensing devices for the internet of things, and 5G applications.

They will contribute towards the four grand challenges identified in the recent government Industrial Strategy – ageing society, the future of mobility, clean growth and AI and the data economy.

In the past, compound semiconductors did not see widespread commercial application and the high production volumes typical for silicon because they were difficult to produce. However, as these challenges are overcome and the cost of manufacturing falls, their special properties mean they will become ever more important in enabling demanding future applications.
BEYOND SILICON

The laser was invented in 1960, but commercialisation only took off in the 1980s with the development of compound semiconductor lasers in CD and DVD players. ‘Vertical cavity surface emitting lasers’ (VCSELs) will drive further innovation with gesture recognition, creating new user interfaces for smart phones and numerous possibilities for virtual reality and augmented reality.

Silicon solar cells convert 25% of the sun’s energy into electrical power, losing the remaining 75%. Compound semiconductor solar cells generate nearly twice the power, providing a clean and renewable energy source with fewer solar farms.

The electricity generated by wind turbines and solar farms cannot be fed into the national grid without being synchronised using power electronics, which currently introduce losses of 10-20%. Compound semiconductors reduce the losses to a few percent, delivering more power to the grid with fewer turbines or solar panels.

An electric engine built with silicon semiconductors is around 75% efficient, it requires liquid cooling and weighs around 150kg. Compound semiconductors will work with new battery technologies to improve the efficiency of electric engines, reduce their weight and extend the vehicle range by up to 2x.

Compound semiconductors enable us to see a broad spectrum of colours, from infrared to ultraviolet, through a process called ‘hyperspectral imaging’. This technique will improve the detection of age-related illnesses, such as cancer, with improved outcomes for society. The same technology can be applied to threat detection at airports, leading to safer travel.

The 5G network will use compound semiconductors to provide 100 billion connections with a latency of 1ms and 10Gbps bandwidth. This will cope with the demands of social media and is high enough for 4k streaming and autonomous vehicles of the future.

www.cs.catapult.org.uk

Launching the Compound Semiconductor Applications Catapult
Imagine a car no longer sits on your drive but arrives driverless at your call. The journey is powered by renewable energy. This same source keeps your home powered, while a smart grid ensures the right amount of energy is delivered.

Everything is connected by lightning-fast 5G communications, from your energy meter to your fridge, washing machine, super-fast computer and television. Augmented and virtual reality bring the outside world indoors. A gesture is all you need to work a phone.

New devices and scanners spot illness more quickly, ensuring you receive the right treatment at the right time. Wearable devices monitor vital systems, communicating with health professionals and making sure treatments are delivered and up to date.

Compound semiconductors – much faster and more efficient than their predecessors – will be at the heart of the devices that power this revolution, generating considerable benefits not only for the UK electronics sector but also for the UK industries that apply them.
The UK has more than 100 companies actively working with compound semiconductor devices. Around 5,000 UK companies, 90% of which are SMEs, are designing and making electronic components, devices, systems and products. These companies could grow if they have support in applying our leading research into compound semiconductor devices.

The Engineering and Physical Sciences Research Council has invested £750 million into compound semiconductor research. Innovate UK, the UK’s innovation agency, made targeted investments of £4 million in compound semiconductor applications in 2016. These investments have created a world-leading research base. We now need to ensure that the UK can translate this into devices and systems that will generate jobs and growth.

Analysts estimate the global market for compound semiconductors will grow from $66 billion today to $308 billion by 2030, a growth rate 3 times faster than silicon. A 3% rise in our share of the market would be worth more than $9 billion by 2030.

Targeted investment and support will not only grow the 100 companies that already use compound semiconductor based devices in their products, but will also expand their use to up to 1,000 further companies within 5 years. By acting now we can ensure that the UK creates a world-leading position.

The Catapult will generate economic growth by making the UK a global leader in developing and commercialising new applications for compound semiconductors.

We will accelerate and de-risk the application of compound semiconductor devices by providing access to critical facilities and expertise and by translating the findings from pure and applied research. We will bring together businesses large and small from across the supply chain to work on collaborative R&D and commercial opportunities. This will give businesses access to support from the emerging compound semiconductor ecosystem and will increase their confidence in using semiconductor devices.

TheCompoundSemiconductorApplicationsCatapult
www.csa.catapult.org.uk
We want UK-based businesses to deliver the new products and services of the future and to take advantage of world-class research in this country. End-user sectors can all grow and thrive if they have the right support to develop new products using compound semiconductor devices. Our aim is to grow the number of UK companies successfully using compound semiconductor devices, and to see economic growth as a result. This will drive growth in the UK electronics sector, keeping more companies ahead of international competition and creating new highly-skilled jobs in the businesses they supply.

The Catapult’s mission is to create a nexus with the mix of expertise, skills, facilities, equipment and collaborations needed for UK businesses to shape the markets of the future and deliver new products, processes and services. We will operate at the heart of a South Wales-based cluster of businesses, research centres and universities with expertise in compound semiconductors, and will connect that expertise to the wider UK infrastructure including businesses, government departments such as health and transport, other Catapult centres and relevant agencies such as the Advanced Propulsion Centre and the Centre for Connected and Autonomous Vehicles.
Key policies include raising R&D investment to 2.4% of GDP by 2027 – a potential extra £80 billion of investment in advanced technology over the next decade – and investing £1.7 billion in Industrial Strategy Challenge Fund programmes in specific areas of opportunity over the next 4 years. The Government has also pledged £1 billion for digital infrastructure, including £176 million for 5G.

The UK government published a white paper in 2017, Industrial Strategy: building a Britain fit for the future. It outlines a set of four grand challenges that compound semiconductors can play a key part in meeting. They are to:

- put the UK at the forefront of the artificial intelligence and data revolution.
- maximise the advantages for UK industry from the global shift to clean growth.
- become a world leader in shaping the future of mobility.
- harness the power of innovation to help meet the needs of an ageing society.

For our future transportation needs will be met by autonomous, electric vehicles connected seamlessly with the digital world. This requires electronic traction, advanced sensors and high-speed communications. Electronic assembly will replace mechanical techniques from 2025, creating around £1.7 billion for UK automotive supply chains.

By 2022, more than 560 million wearable devices will provide real-time analytics to improve health outcomes, including for the UK’s 12 million over 65s. Novel 3D scanning techniques will transform the global cancer diagnostics market, which is forecast to be worth more than $13.1 billion by 2020.
THE CASE FOR SUPPORT

INVESTMENTS SO FAR HAVE CREATED A WORLD-LEADING RESEARCH BASE

The Engineering and Physical Sciences Research Council has invested £750 million in research into the compound semiconductor and its applications: power electronics, radio frequency and photonics over the last decade. Innovate UK, the UK’s innovation agency, made targeted investments of £4 million in compound semiconductor applications in 2016.

These investments have created a substantial and world-leading research base, including a cluster of organisations and businesses in South Wales. This cluster includes the Future Compound Semiconductor Manufacturing Hub, the Compound Semiconductor Centre and the Institute for Compound Semiconductors. The centres are conducting research on the wafers and die on which compound semiconductor devices are based and are piloting production methods.
The UK has world-leading research and businesses and new centres pioneering the production and supply of compound semiconductors. The UK needs an independent centre of expertise that can join researchers and the compound semiconductor supply industry with businesses further along the supply chain that can gain from using compound semiconductors in systems and devices. This centre can provide the world-class expertise and facilities that will allow businesses to fully exploit the potential of advances in these technologies. It will deliver growth back to the compound semiconductor supply industry and ensure that business growth in user industries based on compound semiconductors is kept in the UK and not lost to competitors abroad. A centre working closely with researchers and industry will also increase levels of collaboration and naturally lead to more innovation that the UK can turn into yet more economic growth.

The industry faces challenges in adopting compound semiconductors across the full supply chain. We must ensure the UK will be able to translate research and new production methods into devices and systems further along the supply chain.

Compound semiconductors are more complex to design and manufacture than their silicon relatives and are typically 10 to 100 times more expensive. We need to increase adoption in order to bring the costs down. However, there are several challenges:

• Companies do not have access to the specialist expertise, tools and test facilities they need to validate their prototype products.
• The supply chain is highly fragmented. Companies are reluctant to scale up unless there is a proven market, and users will not develop products with unproven technology.
• There is a lack of awareness among companies of how compound semiconductors could transform their products.

Overcoming the challenges will deliver economic growth both to the electronics industry and to the wider economic sectors supported by the government’s industrial strategy.

The Catapult will establish the UK as the global centre for compound semiconductor thought leadership and technology development, enabling new applications of compound semiconductors, generating economic growth for the UK.
We have worked with more than 150 businesses in developing plans for the Catapult. Our strategy is to drive economic growth by helping UK companies to accelerate the use of compound semiconductors in their products.

The Catapult will achieve its vision and mission by:

• developing an innovation centre that offers capabilities and laboratory facilities required by industry to accelerate the development of new products.
• developing, offering and collaborating on evaluation modules for companies to rapidly explore new compound semiconductor technologies, enabling them to enhance their product range and target new markets.
• stimulating demand across the UK supply chain through challenge-led programmes, which will help a number of prioritised industry sectors apply compound semiconductor technologies in their roadmaps out to 2025 and beyond.

TO ACCELERATE THE APPLICATION OF COMPOUND SEMICONDUCTORS, WE WILL SET UP AN INNOVATION CENTRE AND OFFER EVALUATION MODULES AND CHALLENGE-LED PROGRAMMES
The Catapult innovation centre, at the heart of the compound semiconductor cluster in South Wales, will be a national asset, hosting critical capital and tools giving UK companies access to:

- a design studio where they can work alongside experts to create new products using compound semiconductor technologies.
- the latest simulation and modelling tools to explore concepts for new technologies.
- dedicated laboratories with engineering expertise and specialist equipment for packaging, power electronics, radio frequency/microwave and photonics to allow companies to demonstrate market-readiness of new products.
The Catapult will develop a range of evaluation modules (EVMs). These EVMs will allow many companies to develop prototype systems using UK sourced semiconductors and components, where they can. This activity will stimulate demand for end systems, in turn, driving growth in the supply of devices and services within the supply chain.

Our first modules will be for Power Electronics, Radio Frequency & Microwave and Photonics Applications. Each module will allow many businesses to:

- Accelerate evaluation of new compound semiconductor devices.
- Discover and implement many applications for compound semiconductor devices in new and existing markets.
- Rapidly develop new products.

EVALUATION MODULES REDUCE CYCLE TIME, COST AND RISK FOR INDUSTRY AND DRIVE VALUE BACK INTO THE UK SUPPLY CHAIN.
The Catapult is a long-term investment, and it will take a number of years to realise its full economic impact. However, by 2023, we will aim to have:

The Catapult will focus on the section of the supply chain that puts devices into systems, ultimately helping companies develop new products. This will drive demand for the UK production of devices, creating a sustainable and growing business environment.

WE WILL WORK WITH MORE THAN 1,000 BUSINESSES IN THE FIRST 5 YEARS

The Catapult will invest in programmes that bring together businesses across the supply chain to address global challenges. The programmes aim to help SMEs supply products to corporations with access to large and growing global markets. The first challenge-led programme will be launched during 2018, followed by more in 2019.

ACCELERATING THE APPLICATION OF COMPOUND SEMICONDUCTORS

We will bring together businesses large and small from all over the UK to work together on new applications for compound semiconductors. We will work with other Catapults, government departments, such as transport and health, and agencies such as the Advanced Propulsion Centre, to help them apply compound semiconductors to their own challenges. And we will work with universities to help them translate fundamental research into applications.

WE WILL SEEK TALENT FROM ACROSS THE UK

We will seek and develop talent from across the UK. Secondment programmes, close relationships with academic organisations and working with partners on skills and training will all help with recruitment, and support a strong UK skills base.

WE WILL INVEST IN PROGRAMMES THAT BRING BUSINESSES TOGETHER TO ADDRESS CHALLENGES

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We will seek and develop talent from across the UK. Secondment programmes, close relationships with academic organisations and working with partners on skills and training will all help with recruitment, and support a strong UK skills base.
The greatest opportunities were identified in Power Electronics, Radio Frequency & Microwave and Photonics Applications. We will keep our focus on opportunities that bring the greatest benefits to the UK, and actively mitigate against the risk of losing focus. We will ensure investments are made where we can add most value and are targeted on cutting-edge industry needs.

An independent evaluation of potential challenge-led programmes ranked the market attractiveness of 24 market segments against UK industry’s capacity to benefit in both academic and industrial terms.

**GREATEST OPPORTUNITIES ARE IN POWER ELECTRONICS, RF & MICROWAVE AND PHOTONICS**

Prioritising for Greatest Impact

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There is a need for designers experienced in the use of SiC devices, and this is where we would find an organisation such as the Compound Semiconductor Catapult very useful. We would use their expertise to design and build demonstration and prototype systems, working with us and potential customers to develop power systems using our devices.

Jill Shaw, CEO Anvil Semiconductors

IXYS UK supports the Compound Semiconductor Applications Catapult in the step-change acceleration of the exploitation of compound semiconductor technology in power electronics applications, for example renewable energy and the smart grid, electric vehicle powertrain and more electric aircraft. There is a huge opportunity for the UK to exploit its strong capabilities, both academic and industrial, in emerging and enabling technology and in bridging the interface between them to the benefit of the UK economy.

Phil Townsend, R&D Engineer/Company Secretary IXYS

The Catapult can assist Airbus in meeting its priorities in a number of ways. It will be a focal point in the UK for compound semiconductor activities, which we clearly feel is missing at the moment; there’s a lot of capability but it’s not necessarily coordinated, and in particular it would be useful if they could bring some focus to bear on reliability, which is a key factor in the space business. Looking into the nearer future, we’d be interested in what could be done in the photonics arena and whether or not we could use devices to space that rely heavily on compound semiconductors.

Ralph Green, Research & Development Manager Communications Products Airbus Defence and Space Limited

The Catapult could have a major impact on Microsemi’s business in the UK; it will allow us to work with other companies in the supply chain to tackle bigger projects. It will allow us to identify people at the Catapult to work with others, and it will have a significant impact on the growth of our business as we look to diversity.

Martin McHugh, Head of Technology and Business Development at Microsemi in the UK

It will help us to speed up our R&D cycles, and establish supply chains, local suppliers and providers, which will allow us to invest and grow our business. It should raise the level of UK manufacturing capability in power electronics and sensor systems so that we can deliver more wealth from our innovation.

Paul Taylor, Chief Advisor at Zhuzhou CRRC Times Electric

The National Physical Laboratory will work closely with the Catapult to develop metrology techniques that enable us to characterise the next generation of compound semiconductor devices and systems.

Dr Peter Thompson, CEO, National Physical Laboratory

SUPPORT

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The Compound Semiconductor Applications Catapult is the latest Catapult to be announced by UKRI and joins a prestigious network of Catapults around the UK.

The Catapults are a network of world-leading centres designed to transform the UK’s capability for innovation in specific areas and help drive future economic growth. The Catapult network was established by Innovate UK, and is one of the ways the UK supports innovation in UK business. Each Catapult centre does this by providing access to expert technical capabilities, equipment, and other resources required to take innovative ideas from concept to reality.

The Catapult vision is to bridge the gap between these ambitious businesses and the expertise of the UK’s world-class research communities. A Catapult is:

• A physical centre, with expert staff and cutting-edge equipment.
• An investment by the Government to reduce the risk of innovation and to drive growth in a sector.
• Focused on innovation – Catapults work with companies to help them develop next generation products and services.
• A national asset – it doesn’t matter where our physical HQ is located, we’re here to work with companies across the UK.
• Not a funder; we don’t give out grants but we can work with you as a consortium partner and seek a grant to support our collaboration.

Each Catapult focuses on an area in which the UK has genuine potential to generate growth in strategically important global markets. Our vision is to create the setting which enables you to be part of this success.

Catapult centres are there for all businesses – large and small – looking to undertake late stage research and development and/or commercialise traditional academic research.

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CATAPULT NETWORK