Innovate UK

Results of Competition: **Accelerating the commercial application of compound semiconductors over £100k**

Competition Code: **1607_MM_SEMICON_LO**

Total available funding is £4m across 2 streams

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
Compound Semiconductor Centre Ltd SPTS Technologies Ltd University of Swansea Cardiff University	HEMAN V: High Efficiency MANufacturing of VCSELs	£426,794	£286,025

Project description - provided by applicants

The Compound Semiconductor (CS) diode laser has revolutionised consumer electronics and telecommunications over the last 30 years, enabling mass market adoption of ICT technology such as fibre optical communications, CD and DVD storage. It is now at the heart of new advances in laser based manufacturing methods, medical diagnosis, surgery, cosmetics and sensing. It is the source of choice for commoditisation of laser based technologies, giving an excellent trade-off between specification, cost, energy consumption and footprint. The Vertical Cavity Surface Emitting Laser (VCSEL) is an embodiment which further reduces the footprint of the laser chip so driving additional miniaturisation and cost reduction opportunities. Our project will leverage an existing world leading UK capability in VCSEL materials technology to drive the next wave of commoditised applications such as gesture recognition, ubiquitous high resolution 3D imaging and projection displays. Our consortium brings together compound semiconductor materials, device fabrication and capital equipment specialists in order to faciliate the step change in manufacturing methods required to accelerate the adoption of VCSEL solutions in truly mass market products.

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Sharp Laboratories of Europe Ltd University of Cardiff	Pixel Scale Spectrometry in a Compound Semiconductor Device	£222,220	£136,055

Project description - provided by applicants

This project will develop a micron-size, tuneable, spectral sensor, capable of determining both the wavelength and intensity of incident light. Such a device will have immediate applications in gas sensing and materials detection as a miniature spectrometer, it will also find longer term use in a hyperspectral imaging device if many devices were arrayed. We will be concentrating on two realisations of this device in this project, one based in the visible/IR spectrum to progress an existing proof of principle device and one based in the MWIR to determine this device's "wavelength portability" to an interesting spectral range in which spectral determination is limited and many high value applications exist.

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aXenic Ltd Optocap Ltd	Innovative Microwave Interconnect Assembly For High Speed GaAs Photonic Modulators	£249,563	£163,250
Project description - provided by applicants			
aXenic, a fabless design and manufacturer of high speed GaAs photonic modulators for the analogue radio over fibre and digital optical communications markets, is collaborating with Optocap, a provider of contract package design and assembly services for microelectronic and optoelectronic devices, to develop a new and innovative process for the microwave connection to the chip. Increasing demand for broadband services and increasing congestion on regulated radio spectrum is driving greater penetration of photonics into the wireless arena. A linear optical modulator with high bandwidth accurately transfers the RF signal onto optical fibre. Our current generation of modulators are limited in bandwidth due to the excess RF loss of the connection to the chip. The aim of this project is to realise a low loss, mechanically stable, reproducible connection to reach higher bandwidths for the next generation products. The dimensions of the microwave interconnect, optimised by 3D electromagnetic modelling, will be carefully controlled to realise the desired values of impedance, insertion loss and return loss. Optocap will develop a novel process to form & join the RF connector pin to the planar circuit. This process will be made available to the wider compound semiconductor community.			

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EFFECT Photonics Ltd OpTek Limited Bay Photonics Ltd	Advanced Low Cost Packaging Platform for Compound Semiconductor Applications	£499,496	£349,646
Project description - provided by applicants			
Technological advances in communication and data transfer are increasingly visible all around us, in our homes, our workplaces and also in the businesses and organisations that we depend on. In the last 5 years we have started to take our smartphones, tablets, video calling, Smart TVs, social media, and cloud storage for granted. With our rapidly increasing use of Internet technology, we are experiencing (and forecasting) unprecedented and unrelenting bandwidth growth. As Internet users, we demand more bandwidth, but we are unwilling to incur further cost. The number of datacenters (DCs) is increasing to meet this bandwidth demand. DCs are interconnected using optical communications modules. Modules must be compact and cost effective to enable price friendly™ bandwidth. Project ALPACKA (Advanced Low cost PACKAging for compound semiconductors) will develop a design concept for an fully automated, low cost and compact packaging platform that will enable cost effective and compact Indium Phosphide (InP) Photonics Integrated Circuit (PIC) optical communication modules.			

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Anvil Semiconductors Ltd University of Bristol	Application Engineering of 3C-SiC Power Devices	£265,723	£209,439
Project description - provided by applicants			
The project's goal is to make low-cost 3C-Silicon Carbide (SiC) power devices ready for real-world power applications. Power conversion is a major area of inefficiency in all power systems with silicon (Si) based systems reaching their limit. The use of compound semiconductors in power conversion is widely accepted as a route to a significant increase in efficiency and reduction in size/ weight. However, penetration of SiC devices has been limited by their high cost; currently an order higher than Si equivalents. Anvil has developed a unique technology that, by growing 3C-SiC on Si wafers, has the potential to enable the production of SiC components at a similar cost to Si ones, hence eliminating this barrier to their adoption. Anvil has early prototype devices but achieving the maximum efficiency in applications using wide bandgap semiconductors is not simple. It needs high-speed drivers, novel inverter designs, closed coupled layouts and high-temperature packages. This is best done as a system of device and inverter together rather than piece part design. The purpose of this project is to do exactly that; using models and simulations to optimise circuits and feedback optimal device design characteristics and demonstrate the potential user benefits of 3C-SiC power converters.			

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M-Squared Lasers Ltd University of Glasgow	LOTUS: Lifetime OptimisaTion for Ultrafast SDLs	£499,090	£393,358
Project description - provided by applicants			
Novel low cost ultrafast lasers are enabling wider adoption of leading microscopes for life science research. Microscopes enable medical research to be undertaken and the development of new medicines that save lives. M Squared Lasers (MSL) have recently developed a novel semiconductor laser, that is capable of replacing Ti:Sa based lasers for ultrafast applications such as in microscopes. However, unsatisfactory gain material is holding this technology from reaching market. In this project we will develop a process for improving compound semiconductor material growth to enable effective thermal management for optimum laser emission intensity. This apparatus will enable M Squared to deliver a low cost ultrafast laser system to market. Furthermore, a strong regional and UK based supply chain will be developed.			

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DZP Technologies Ltd Anvil Semiconductors Ltd	Silicon Carbide Interconnect Optimisation Project	£243,174	£170,222
Project description - provided by applicants			
The Silicon Carbide Interconnect Optimisation Project (SCIOP) aims to develop a novel form of die interconnect for the power electronics sector. The project objectives are to explore alternative materials, processes and adhesion technologies which can contribute to improved power module performance and simplified production processes. Improved performance and reduced cost in the enabling technologies of power electronics, due to the pervasive nature of the technology (electric motors, power grids, etc.), has the potential to make a significant contribution in helping the UK exploit semiconductor innovation and in a broader context help move to a low-carbon economy.			

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Dynex Semiconductor Ltd University of Warwick Cambridge Microelectronics Ltd	TRASiCA:High current 3.3kV SiC Schottky diodes for hybrid modules in traction applications	£499,840	£348,864
Project description - provided by applicants			
TRASiCA will demonstrate the gains in performance and system lifetime that can be brought about in the traction industry by integrating silicon carbide (SiC) power device technology into existing systems. A hybrid SiC™ power module incorporating SiC power diodes with state-of-the-art Si trench IGBTs will be produced for Dynex Semiconductor's customer Fertagus, and the performance benchmarked on the train network in Lisbon, Portugal, against the current silicon state-of-the-art. The SiC diodes used within this project represent a significant innovative step, given that devices of the required high current and high voltage (>50A, 3.3 kV) are not available on the market. Therefore, the diodes used within the module will be designed within Cambridge Microelctronics (Camutronics), and fabricated at Warwick University, so that they are specifically tailored for the application they serve. This will come after an exhaustive feasibility study that will compare the suitability of many SiC diode technologies for the target application.			

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Gas Sensing Solutions Ltd INEX Microtechnology Limited University of Glasgow	Novel Mid Infrared III-V Light Sources & Detectors enabling Autonomous Gas Sensors	£429,773	£333,104
Project description - provided by applicants			
This project addresses a rapid growth global market requirement, in many cases legislatively driven, for mass produced ultra-low power consumption gas sensors. The project will achieve a step change reduction in gas sensor power consumption through significant enhancement of current epitaxially grown compound semiconductor light source (light emitting diode [LED]) and photodiode detector (PD) performance. Enhanced performance would be achieved through development of novel mid infrared (MIR) edge emitting LED`s (EELED) and photodiode detector (PD`s) devices, utilising antimonide epi-grown bandgap structures. The project provides MIR EELED`S and PD`s tuned to specific gas absorption bands for use as the mid infrared light source and detector respectively in optical based gas sensors. Such ultra-low power consumption devices enable low cost fit & forget'•deployment of gas sensors specifically in smart wireless autonomous sensor networks. The consortium provides a manufacturing supply chain to implement new processes, light sources & detectors through to complete gas sensors. The project advances the Technology Readiness Level of EELED and PD capability to a late stage pre-commercial level, i.e. >TRL6.			

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Evince Technology Ltd University of Newcastle TMD Technologies Limited	REDEFINE - Robust Embedded Diamond Field Emitter for microwave amplification	£290,514	£225,288
Project description - provided by applicants			
Electron emitter devices are used in a broad range of applications including RF amplifiers for communications and RADAR. Increasing need for global communications driven by market demand for live, streaming video quality data for mobile users is limited by existing infrastructures and technologies. Travelling wave tubes (TWTs) remain an important enabling technology for this sector, creating RF amplification for communications at greater than double the efficiencies that the best alternatives have been able to deliver. However, TWTs are currently constrained to thermionic electron sources that intrinsically limit lifetime. Using wide bandgap materials that combine high electron mobilities and excellent thermal performance coupled with advanced semiconductor concepts and manufacturing techniques, electron sources can be realised in the solid-state that eliminate the need for heating. The REDEFInE project, redefines the concept of the cold cathode electron source by creating novel field emitting structures embedded within the substrate material, delivering optimised thermal management with no inherent wear mechanisms - in-turn yielding much longer life and better performance.			

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IQE PLC European Thermodynamics Ltd University of Cardiff Bangor University	Device Enhanced Performance of Integrated Concentrator Photovoltaics & Thermoelectrics	£420,122	£300,885
Project description - provided by applicants			
Concentrator Photovoltaics (CPV) are a potentially a cost-effective alternative to conventional flat-plate solar modules, due to the use of cheap plastic optics which concentrate sunlight. CPV cells have the highest photon to electricity conversion efficiency (46%) which can be further improved under optical concentration. The small size of standard CPV cells (0.3-1 cm2) potentially leads to very low electricity costs. However, the CPV cell temperature needs to be cooled to optimise power generation, currently done via passive (heat sink) or active (water cooled) systems, often inefficient or complex / expensive. Thermal energy (up to 50% of the incident photon energy) can be controlled effectively with reliable solid-state thermoelectrics (TE) technology, demonstrated at proof-of-concept at Cardiff University. This collaborative project brings together manufacturers of CPV epitaxy (IQE plc) and TE modules (ETL) with proven academic expertise in manufacturing electronic CPV-TE receivers (Cardiff Univ.), and lifetime & reliability testing (Bangor Univ.). The project outcomes will be optimized theoretical designs and manufactured prototypes of novel CPV-TE receivers, lowering costs of renewable energy generation and building the UK CPV supply chain via technical innovation.			

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M-Squared Lasers Ltd Optocap Ltd Kelvin Nanotechnology Ltd University of Glasgow	PROPEL: Power Scaled DFB Lasers for Portable Spectroscopy	£497,916	£369,372
Project description - provided by applicants			
The market for handheld and portable Raman spectrometers is rapidly growing (10% CAGR) whilst progress is being made towards the development of methods to overcome the background fluorescence that has traditionally held the method back. M Squared have developed a handheld Raman spectrometer for the authentication of whisky, and are adapting this technology for healthcare applications based on proprietary background subtraction techniques. Handheld spectrometers require high performance with enough power and spectral purity to allow accurate species identification, whilst being compact, robust and low cost. At present high precision laser sources used for high resolution spectroscopy have external cavities which are bulky limiting their use in the field. During this project the consortium will develop power scaled lasers based on innovative processes that make use of the unique qualities of compound semiconductors to deliver improved light intensity. The power scaled laser will be low cost and rugged, and able to provide high precision analysis for handheld spectrometry. The enabling of high precision handheld spectrometry will enable applications in precision medicine, as well as quality monitoring in the food & drink industry.			

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Compound Semiconductor Centre Ltd CyDen Limited University of Swansea	C4ST:Centre for Cosmetic & Curative applications of Compound Semiconductor Tech	£422,035	£295,355
Project description - provided by applicants			
There is a growing demand for Curative, Cosmetic and Diagnostic technologies to transition from the clinical environment to the home. Photonic solutions are enabling high-end consumer products such as laser hair removal, anti-wrinkle treatments, acne and blemish reduction. LED solutions have enabled consumer self-diagnostics such as pulse oxymetry, and are now being used routinely in fitness and lifestyle monitors. Next generation photonic applications on the short term horizon include non-invasive glucose monitoring, hydration evaluation and breath analysis as wearable technology. There is one common enabler across this market: compact, portable, commoditised laser, LED sources and detectors that can offer adequate wavelength discrimination, consumer grade reliability and safety. Increasingly LED solutions are out-competing lamp based technologies due to reduced power consumption, and for laser grade specifications, compound semiconductor diode lasers are the only viable solution. C4ST brings together device specialists and clinical application scientists in the cosmetic, curative and diagnostic domain in order to address the huge opportunities for accelerating the use of compound semiconductors in the home healthcare, lifestyle and diagnostic markets.			

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