Call for Feasibility Studies

EPSRC Future Manufacturing Hubs

Call Type: Invitation for Proposals

Closing Date: 16:00 on Friday 15th November 2019

Related themes: Manufacturing the future

Summary

The **EPSRC Future Manufacturing Research Hubs** in **Composites, Compound Semiconductors, Metrology** and **Photonics** have partnered to offer up to £1 million in funding to support a number of Feasibility Studies at TRLs 1 to 3. The funding is available for novel research in manufacturing technologies pertinent to the priority areas identified by each of the four partner Hubs (see: Scope of the Call). The joint call is open to all UK academics eligible to receive EPSRC funding and is the primary mechanism for new academic collaborators to engage with the four Hubs. The partnership is motivated by the possibility for collaborations spanning multiple Hubs, in projects where the research area is of mutual interest to more than one Hub. In addition to maximising potential research synergies, the joint call also offers projects access to facilities and equipment from all four Hubs.*

Proposals are envisaged to have a maximum duration of six months and maximum value of **£62,500 at full Economic Cost (fEC),** with funding to be awarded at 80% of fEC.
*(Subject to terms and conditions).

Key Dates

Activity	Date
Call Launched	Monday 23rd September 2019
Closing date for applications	**16:00 on Friday 15th November 2019**
Evaluation of applications by	Friday 29th November 2019
Grants announced and feedback given by	Friday 6th December 2019
Projects must start within 3 months of receipt of the offer letter	

Background

To help manufacturing industries respond to future opportunities and contribute to a prosperous UK, the EPSRC decided to build on the success of the Innovative Manufacturing Research Centres and the EPSRC Centres for Innovative Manufacturing to create a network of Future Manufacturing Research Hubs. Each Hub has a programme of innovative research in the engineering and physical sciences, related to the challenges in commercialising early stage research. The core Hub activity is based in a single location, with other institutions or groups acting as 'spokes', providing specific expertise in particular areas complementary to the lead institution. A key characteristic of the Hub model is that the research is driven by the long-term research challenges of users. User collaboration is therefore an essential aspect for these Hubs. There are currently 13 Future Manufacturing Hubs, four of which have partnered to create this call.

1) The **Future Composites Manufacturing Research Hub** was established in 2017 to engage academics from across the UK to deliver a step-change in the production of polymer matrix composites. Building on the success of the EPSRC Centre for Innovative Manufacturing in Composites (CIMComp), the Hub is driving the development of automated manufacturing technologies that deliver components and structures for demanding applications, particularly in the aerospace, transportation, construction and energy sectors. The Hub is led by the Universities of Nottingham and Bristol with 12 other academic spokes, 4 High Value Manufacturing (HVM) Catapult Centres and 22 industry partners across a range of sectors and tiers.

2) The **Future Compound Semiconductor Manufacturing Research Hub** was established in 2016 to engage academics from across the UK to deliver a step change in the manufacturing of Compound Semiconductors. The Hub is led by Cardiff University and includes Spokes at the University of Sheffield, University College London and the University of Manchester. It is backed by more than 40 companies involved in the manufacturing of compound semiconductors or their applications and other organisations such as NPL and works closely with the Compound Semiconductor Applications Catapult.
The vision for the Hub is to reduce cost and increase volume by applying the manufacturing approaches of Silicon to Compound Semiconductors (CS) e.g. generic functionality; develop integrated CS and Silicon (Si) manufacturing to exploit the highly advantageous electronic, magnetic, optical and power handling properties of CS while utilising the cost and scaling advantage of Silicon where it is best suited; apply the manufacturing advances across the different families of CSs and combine these different CSs to generate novel integrated functionality; and change the UK academic mind-set to start with “manufacturable” research.

3) The **Future Metrology Hub** was established in 2017 and aims to transform the UK’s manufacturing performance by delivering significant improvements in the speed, accuracy and cost of measurements. This will be achieved by developing ground-breaking embedded metrology technologies and universal metrology informatics systems to be applied across the manufacturing value chain. The Hub is led by the University of Huddersfield with academic research spokes at the University of Bath, Loughborough University and the University of Sheffield. It is supported by the National Physical Laboratory (NPL), and 5 High Value

Manufacturing (HVM) Catapult Centres. It is also backed by over 40 leading companies and institutions in the sector.

4) Established in 2016, the **Future Photonics Hub** is delivering a programme of manufacturing research under the grand challenge of photonic integration. The Hub is led by the University of Southampton in partnership with the University of Sheffield. With four technology platforms, covering fibre, light generation, silicon photonics, and large scale manufacture of 2D and metamaterials, the Hub collaborates with a wide range of partners in academia and industry. By exploiting new functional materials and processes, the Hub is improving the manufacturability and integration of photonics, leading to low-cost manufacturing processes to provide lower-cost, higher-performing integrated sensors, lasers and sub-systems, and accelerating the wider adoption of photonics technology.

Scope of the Call

Research proposals should address challenges at low TRLs (1-3) and be aligned with at least one of the priority areas outlined by the individual Hubs below. Full details of each Hub's objectives and a more in depth explanation of the topics can be found in the relevant annex.

Proposals should demonstrate the potential, if feasibility is demonstrated, to significantly improve the U.K.'s manufacturing capabilities. As such, industry are encouraged to participate as project partners to demonstrate a pathway to manufacturing and exploitation, although cannot receive funding directly.

The Future Composites Manufacturing Research Hub is seeking proposals which may include the development of new manufacturing technologies, analytical studies to develop a fundamental understanding of state-of-the-art processes, or the development of process modelling and optimisation techniques. In the following areas:

- High rate deposition and rapid processing technologies.
- Design for manufacture via validated simulation.
- Manufacturing for multifunctional composites and integrated structures.
- Inspection and in-process evaluation.
- Recycling and re-use.

Proposals **must** focus on the manufacturing of composite structures rather than the development of new materials. Nanomaterials or graphene are not considered to be within the scope of the Hub.
Informal enquiries are welcome to check if proposal ideas are within scope.

The Future Compound Semiconductor Manufacturing Research Hub is seeking proposals that address the challenge of integrating functionality using compound semiconductors including electronics, optoelectronics and sensors or integrate different compound semiconductors and silicon measurement of materials and structures becomes critical. This includes:

- Metrology for compound semiconductors.
- Integrated compound semiconductors for metrology.

- Magnetic sensors
- Electronics
- Optoelectronics

- Manufacturing of compound semiconductors (CS) and CS on Silicon (epitaxy, fabrication and process control).

The Future Metrology Hub is seeking proposals which address specific industrial challenges in applied
metrology. Proposals should seek to develop new metrology technology or techniques or adapt and develop existing methods to be suitable for use in the following applications:

- Metrology for control.
- Metrology for composites.
- Metrology for high temperature forming.

Proposals which make use of sensor networks or in-process/embedded metrology are of particular interest.

The Future Photonics Hub is seeking proposals that address the grand challenge of photonic integration, support the development of the technology platforms, or new applications of Hub developed technology. The hub is seeking proposals in the following areas:

- Photonic integration: The aim of this platform is the grand challenge of integrated devices across all four platforms with an eye on cost reduction, manufacturing efficiency, and the capture of 'smart' value at component level.
- Speciality optical fibre: Focus on two key challenges in fibre manufacturing to meet short and longterm industry needs: improving loss, gain and power handling and increasing the transmission window to enable new applications.
- Light generation and delivery: Devices such as quantum-cascade lasers, antimonide-based lasers/LEDs and fibre supercontinuum sources have generated new markets in areas such as sensing, imaging, healthcare and spectroscopy. This platform will drive the transition required for growth in these photonics-enabled industries, from discrete components to low-cost, compact, integrated platforms.
- Silicon photonics: Silicon photonics has made major advances in functionality at the chip level, but integration remains an obstacle to the development of the technology. New directions within the Hub include hybrid integration (e.g. for efficient modulators) and diamond photonics circuits.
- Large-scale manufacture of metamaterials and 2D materials: Metamaterials and 2D materials provide extraordinary properties that disrupt conventional ideas on device performance. This platform focuses on low-cost, scalable manufacturing of metamaterials that has so far been an obstacle to their proliferation in devices and systems.

Funding available

Each of the four Hubs is providing funding for up to 5 Feasibility Studies in their subject area. The maximum funding available for each Feasibility Study is £62,500 at fEC, of which 80% will be funded by the Hub (i.e. maximum grant per project of £50,000). Maximum project length is six months and funding is intended to cover the costs of the PI and supporting researchers in undertaking their research feasibility project. Funding will therefore primarily cover staff time (including associated Indirect and Estates costs), with the remainder supporting consumables and travel. Funding for PhD students is not available.

Equipment

Funding for the purchasing of equipment is not eligible.

The partner Hubs are committed to supporting the U.K.'s research community and have jointly agreed to provide access to facilities and equipment at cost to proposals funded through this call (subject to terms and conditions agreed on a case by case basis). If you believe that your proposal would benefit from access to specialist equipment available at any of the partner Hubs, please contact the relevant Hub Manager using the details provided in the contacts section. They will be able to advise you on the cost and availability of equipment which can then be incorporated into your proposal.

Eligibility

This call is open to all UK academic institutions (including existing Hub and Spoke institutions), where applicants must be eligible to hold an EPSRC grant. If you need guidance on eligibility, please visit https://www.epsrc.ac.uk/funding/howtoapply/fundingguide/eligibility/investigators/.

How to apply

Feasibility Study applications should be submitted in MS Word and/or PDF format to the relevant Hub Manager using the contact details provided above. If your proposal is relevant to more than one Hub please send a copy to all the relevant Hub Managers, using the details provided in the contacts section, and indicate to which Hub your proposal is most closely aligned.

Applications should be no more than four sides of A4, using 2cm margins and a standard 11pt Arial font. Proposals should include, but not be limited to, the following content:

1. Research title, institution name and full name of the Principal Investigator (PI).
2. Start date and duration. (Projects should typically last for a maximum of 6 months)
3. Identify which call topic(s) is being addressed and identify any elements of the proposal which are relevant to the other Manufacturing Hubs.
4. Context, aim and objectives of the research, including a description to explain how the study fits within the overall vision of the Hub and how it supports one of the research priority areas.
5. A statement of the novelty of the proposed research, including some evidence that it is not being addressed elsewhere.
6. A description of the methodology to be used, including a timing and resource allocation plan.
7. Provide details of any access to Hub equipment or facilities required and include costs and associated timescales.
8. A description of the tangible deliverables from the Feasibility Study (what does success look like?)

9. A plan to show how you will attract further funding if your idea is feasible and the research is successful.
10. Any evidence of industrial interest or support.
11. A brief track record of the applicants relevant to this research area.
12. Justification of resources, summarising Directly Allocated (staff, estates costs, other), Directly Incurred (investigators, travel, consumables, infrastructure etc.), and Indirect Costs. A limit of 3.75hrs/week is imposed for Investigators, regardless of the number of co-investigators*.

*(this clause is included to ensure the majority of resources are directed towards carrying out research activities)

Assessment process

Submissions will be considered by a panel consisting of Hub Investigators supported by independent assessors to ensure a fair and unbiased process. In order of importance, the evaluation criteria for applications will be:

1. **Suitability**: Does the proposal address one or more of the topics outlined in the call and is the proposal at an appropriate TRL?
2. **Research Quality**: Is the proposal likely to result in high quality research outcomes, in the form of journal publications, patents etc.?
3. **Novelty**: Does the proposal contain genuine scientific novelty and is the work timely? Is it being addressed elsewhere?
4. **Relevance**: Is the proposal relevant to the interests of industrial partners or represent the opportunity to significantly improve the U.K.'s manufacturing capability?
5. **Ambition**: Does the proposal offer suitable levels of challenge, ambition and risk? High-risk, high return studies are encouraged.
6. **Potential**: Is the approach credible and will the team be able to deliver? If feasibility is demonstrated is there potential for developing a larger collaborative project, either at a similar fundamental level or at higher TRLs?
7. **Planning**: How well has the proposal been planned? Are the requested resources appropriate to deliver the proposed programme within the timeframe and have they been fully justified?

Contacts

Applicants are asked to consult their university's research office ahead of submitting a proposal to this call, in order to be clear of the requirements for meeting the deadlines set out above.

For more details, please contact the relevant Hub Manager using the details below:

Future Composites Manufacture Hub – enquiries@cimcomp.ac.uk

Future Compound Semiconductor Manufacturing Hub – Future-CSHub@cardiff.ac.uk

Future Metrology Hub – metrology@hud.ac.uk

Future Photonics Hub – contactus@photonicshubuk.org

Annex A: Future Composites Manufacturing Hub

Research must be novel and fundamental, addressing low TRL (1-3) problems. Applicants are invited to submit proposals that are complementary, but distinct, to the current research being conducted by the Hub (www.cimcomp.ac.uk/#research). Proposals should also fit within the overall vision of the Hub and address one of the Hub's two Grand Challenges:

- To enhance the process robustness of existing processes via the understanding of the processscience (to deliver and accelerate growth).
- To develop new high-rate processing technologies to deliver high quality structures (to develop new technologies and diversify into emerging sectors).

Projects can include the development of new manufacturing technologies, analytical studies to develop a fundamental understanding of state-of-the-art processes, or the development of process modelling and optimisation techniques. **Proposals must focus on the manufacturing of composite structures rather than the development of new materials**. Nanomaterials or graphene are not considered to be within the scope of the Hub.

Proposals must also fit within one of the following priority areas:

1. High rate deposition and rapid processing technologies
Proposals in this area should focus on overcoming manufacturing related challenges to improve quality, reduce cost or increase rate. Key deliverables include fundamental understanding of primary drivers such as component complexity, automation limitations and optimal processing windows. Projects developing new feedstock materials or conducting extensive material test programmes will not be funded.

2. Design for manufacture via validated simulation
Proposals in this area should focus on the virtual design and development of composite structures, such as validated process simulations capable of predicting viability and arising component quality. These tools will support existing relevant processes, or enable new automated processes to be introduced with confidence.

3. Manufacturing for multifunctional composites and integrated structures
Proposals in this area should demonstrate cost-effective and reliable routes to produce multifunctional composite structures at high rate. Projects should focus on developing existing implementations beyond the laboratory scale to the structural scale, ensuring they are compatible with relevant composite fabrication techniques. Multifunctionality may include mass/ heat/ charge transport capabilities, but these must be delivered within structural configurations, such as doubly-curved surfaces, sandwich panels and plates with stiffeners.

4. Inspection and in-process evaluation

Proposals in this area should focus on developing or improving the capability to make in-process measurements to evaluate preform or component quality, enabling corrective action to be taken to reduce/eliminate rework and scrap. Projects developing inspection and NDT techniques for postmoulded or in-service components will not be funded.

5. Recycling and re-use

Proposals of interest in this area include demonstrating a manufacturing methodology with the potential to produce structural components from recyclates at industrial production rates, or reducing the amount of in-process waste by developing more efficient processes to minimise the use of virgin fibre. Projects characterising the properties of recyclates from new fibre recovery methods will not be funded.

Projects which address one or more of our current priority areas are identified by our Research Challenge Landscape are especially welcome

Please note that this will not be the primary measure of success for proposals. Scientific excellence remains the primary criteria for assessment of proposals. https://cimcomp.ac.uk/research-landscape/

Annex B: Future Compound Semiconductor Manufacturing Hub

For this feasibility call we target integrated compound semiconductors including electronics, optoelectronics and sensors or the integration of different compound semiconductors and silicon with a focus on measurement of materials and structures.

Metrology for compound semiconductors

Metrology for compound semiconductors includes aspects of metrology for epitaxial growth including dimensional compositional control, metrology for patterned lithographic structures and challenges in measurements of complex integrated systems on wafer. The latter includes the relationship between measured parameter during fabrication process and final device or integrated circuit performance.

Integrated compound semiconductors for metrology

Integrated Compound semiconductors for metrology includes sensing, imaging and spectroscopy using approaches that are, or provide routes to, integrated chip format. This includes advanced magnetic, electronic or photonic sensors, electronics and optoelectronics.

The design of advanced linear/non-linear encoders using highly sensitive compound semiconductor magnetic sensors based on 2-Dimensional electron gas (2DEG) system in strained InGaAs/GaAs and InGaAs/InAlAs materials. The key aim is the development of robust encoders based on magnetic field sensing with unprecedented resolution and sensitivity for use in applications when optical encoders might not be suitable. The two key challenges in manufacturing to meet both short and long-term industry needs include improved power consumption, higher sensitivity and especially integration with drive electronics.

The design and realisation of integrated laser sources and other active and passive components for e.g. LIDAR / Interferometry. The key aim is the development of robust systems with resolution and sensitivity approaching that of discrete systems.

Manufacturing of compound semiconductors

New methods for low energy and resource efficient manufacturing of compound semiconductor wafers.

Processing challenges in the development of multilevel functionality in Compound Semiconductors.
Use of vias, air bridges etc. and the statistical evaluation of fabrication tolerances and process control.

A key generic challenge for III-V on Si fabrication is handling thermal stress cycles during growth and processing. Assessment of performance and statistical process control is of interest.

Proposals and enquiries should be directed to Future-CSHub@cardiff.ac.uk

Annex C: The Future Metrology Hub

The Future Metrology Hub has two key research themes:

Theme I: Embedded Metrology will build sound technological foundations by bridging four formidable gaps in process and component-embedded metrology. This covers: physical limits on the depth of field; high dynamic range measurement; real-time dynamic data acquisition in optical sensor/instruments; and robust, adaptive, scalable models for real-time control systems using sensor networks with different physical properties under time-discontinuous conditions.

Theme II: Metrology Data analytics will create a smart knowledge system to unify metrology language, understanding, and usage between design, production and verification for geometrical products manufacturing; establishment of data analytics systems to extract maximal information from measurement data going beyond state-of-the-art for optimisation of the manufacturing process to include system validation and product monitoring.

The resulting pervasive embedding and integration of manufacturing metrology by the Hub will have far reaching implications for UK manufacturing as maximum improvements in product quality, minimization of waste/rework, and minimum lead-times will ultimately deliver direct productivity benefits and improved competitiveness.

The Future Metrology Hub has identified the following topics relevant to specific industry sectors which would enhance our research programme.

Metrology for control

With the rapid progression of Industry 4.0, integrated metrology systems are becoming increasingly common. To extract maximal value from networks of integrated metrology sensors (Sensornets) sophisticated data processing and analysis solutions are required to analyse and evaluate the large quantity of data generated. These systems can be used to form a closed loop in which manufacturing processes are continuously monitored and controlled. Novel methods of managing sensornets or optimising the acquisition and/or processing data should be proposed with the aim of using metrology data to inform process control operations.

Metrology for composites

The manufacture of composite parts presents a number of specific metrology challenges encompassing all scales from macro to micro. These challenges include, but are not limited to, assessing the form accuracy of the finished part, determining fibre orientation during the manufacturing process and confirming the void levels and defects within the polymer matrix. Proposals in this area should seek to address these challenges using novel applications or developments of existing metrology techniques in a manner suitable for adoption in a production environment.

Metrology for high temperature forming

High temperature forming techniques such as hot/warm forming, extruding and casting present a significant challenge for dimensional metrology. The use of embedded sensors for in-process measurement is hampered by the raised temperatures which necessitates the development of robust sensors. Additionally, thermal expansion and contraction of the tooling and workpiece throughout the process make repeatable and reliable measurement difficult. Proposals in this area should seek to address these challenges through the development of sensor technologies or thermal error modelling and compensation strategies.

For more information about these topic areas or to submit an application to the Future Metrology
Hub, please direct enquiries to metrology@hud.ac.uk

Annex D: The Future Photonics Hub

Proposals, and any questions, to be submitted to The Photonics Hub email address: contactus@photonicshubuk.org

1) Photonic integration
Contacts: Prof Jon Heffernan, Prof Gilberto Brambilla

Proposals involving integration of two or more of the above themes are particularly welcome. Example topics could include:

• Integration of 2D materials into III-V and silicon photonics platforms.
• Large-scale, low-cost optical fibre integration with III-V sources.
• Integration of diverse materials to enable quantum technologies such as superconducting nanowires, diamond films and quantum dots.
• Integration of sources with planar passive devices leading to miniaturised systems e.g. for Lidar.
• Methods to enable efficient planar coupling of on-chip waveguides to detectors.
• Novel methods of improving efficient out-coupling from waveguide technology.

2) Speciality optical fibre
Contacts: Prof Jayanta Sahu, Prof David Richardson, Prof Michalis Zervas

The focus is on two key challenges in fibre manufacturing to meet short and long-term industry needs: improving loss, gain, power handling and increasing the transmission window to enable new applications.

- Developing volume-scalable, cost-effective, manufacturable special (passive and active) fibres for
- use in ultra-high-power light sources and transmission.
- Designs and processes for cheaper, more reliable and efficient near-IR fibre lasers and systems.
- High power diode pumped Raman fibre lasers.
- Diode-pumped visible fibre lasers.
- Next-generation solid-core and microstructured fibre technologies interfacing with other optical
- and electronic platforms.
- Manufacturing technologies such as 3D printing for making optical fibre preforms.
- Optical coating materials for optical fibres in high power lasers and harsh environment applications.

3) Light generation and delivery
Contacts: Prof Jon Heffernan, Prof Francesco Poletti

Novel Devices emitting in the near- to mid-infrared spectral region, such as semiconductor lasers/LEDs and fibre supercontinuum sources that generate new markets in areas such as:

- Sensing, imaging, healthcare and spectroscopy. This platform will drive the transition required for
- growth in these photonics-enabled industries, from discrete components to low-cost, compact,
- integrated platforms.
- New methods for low energy and resource efficient manufacturing of semiconductors wafers.
- Reliable and integrated mid-IR delivery fibres.
- A manufacturing platform for compound-glass hollow-core fibres.

- Novel fabrication methods for microstructured fibre pre-forms (e.g. 3D printing) to improve fibre precision, yield, flexibility and integration with new light sources.

4) Silicon photonics

Contacts: Prof Graham Reed, Prof Goran Mashanovich

Silicon photonics has made major advances in functionality at the chip level, but integration remains an obstacle to the development of the technology. This platform focuses on solutions to this key challenge.

- Hybrid integration of silicon with materials including LiNbO3, BaTiO3.
- Fabrication of diamond photonic components.
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5) Large-scale manufacture of metamaterials and 2D materials

Contacts: Prof Nikolay Zheludev, Prof Kevin MacDonald, Prof Dan Hewak, Prof Martin Charlton

- Large scale manufacturing of metamaterials.
- Electrically pumped compound chalcogenide semiconductor lasers.
- 2D Chalcogenide FET sensors for quantification of enzymes and bacteria.
- Energy storage using emerging chalcogenide based compound semiconductors.
- Novel devices or manufacturing processes for flexible photonics, nanostructured photonics, and hybrid displays.
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For more information about The Future Photonics Hub, see www.photonicshubuk.org

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CIMComp EPSRC Future Composites Manufacturing Research Hub
CS Hub
The Future Metrology Hub
The FUTURE PHOTONICS Hub
Advancing the manufacturing of next-generation light technologies