Manufacturing Advanced Functional Materials

Call type: Expression of Interest

Closing date: 16:00 Tuesday 15 April 2014

Summary

Functional materials are a unique class of materials that display specific characteristics based on their own native physical and chemical properties, rather than exhibiting purely load-bearing capacities. This behaviour opens up a vast range of enhanced properties that could translate into next-generation applications and novel products. Whilst the UK is world-leading in many areas of material science and engineering, the development of functional materials into applications across all industrial sectors remains in its infancy.

Therefore, EPSRC are inviting research proposals from consortia across the Engineering and Physical Sciences communities to address the manufacturing research challenges in developing applications, production technologies and future processes that incorporate advanced functional materials.

EPSRC are expecting to commit up to £10 Million on large, long term (up to five years), multidisciplinary programmes. A two-stage process will be used to allocate the funding. This first stage of the call seeks expressions of interest to submit a full proposal. The submitted expressions of interests will be assessed at a short-listing panel in May 2014 and those that align appropriately with the scope for this call will be invited for the full proposal stage. The deadline for full proposals will be in July 2014 and these will be peer reviewed during the summer. Funding decisions are expected to be made in Autumn 2014.

Background

The Rise of Advanced Functional Materials

Throughout history materials have played an important part in realising society's technological needs. Raw materials such as wood and stone were first used in early civilisations to build boats and houses before people discovered metals and crafted them into weapons, scientific instruments and vehicles. More recently, the diversity and versatility of plastics has been demonstrated with its inclusion into countless applications from car parts, food packaging and computers. Established materials such as these are primarily used because of their mechanical or structural properties (i.e. they are strong, tough, malleable or lightweight). However, in the last 100 years significant technological advances have been influenced not by structural materials, but by the discovery and use of a class of materials known for their functional properties.

Functional materials are distinctly different from structural materials in that they are materials that exhibit specific behaviours other than possessing a load

bearing capacity. In other words, functional materials respond to external stimuli (optical, electrical, magnetic, thermal etc..) by utilising their own native physical and chemical properties. Examples of functional materials are semiconductors, magnetic materials and piezoelectric materials.

The effect that functional materials have had upon modern society cannot be over-estimated. It was only through the development of semiconductor devices that our modern information-based society has emerged and transformed into a global market in excess of $304 billion[1], with wider benefits for human health, well-being and global communications.

Over recent years we have also seen the emergence of bespoke, tailored advanced materials that exploit coupling between multiple variables which presents a vast range of enhanced functions that could translate into future applications and new products. In contrast to materials that simply have a non-structural (and often singular) function, we can define these designer functional or smart materials (such as metamaterials) as **Advanced Functional Materials**.

A recent market report predicted that the global market for Advanced Functional Materials is expected to generate revenue of $113 billion by 2018[2]. To help realise the potential economic impact of these advanced functional materials is not only an exciting scientific opportunity, but also technologically compelling since these materials could play an increasingly crucial role in the next-generation of intelligent devices and sensors, smart homes or autonomous materials systems.

To enable advanced functional materials to thrive in the industrial world, we need to understand the integration of these materials with components, the demands for performance and reliability, and the requirements for new assembly processes and manufacturing techniques to realise this.

UK manufacturing context

The potential for advanced materials to underpin future prosperity is already being recognized by major international initiatives such as the United States Materials Genome Initiative, a national innovation infrastructure which aims to enable American institutions to accelerate the development of new materials from discovery to exploitation into novel products.

Advanced materials is one of the UK government's Eight Great Technologies, and is a key enabler for advanced manufacturing. UK businesses that produce and process materials have a turnover of around £170 billion per annum, represent 15% of the country's GDP and have exports valued at £50 billion.

The 2013 Foresight Future of Manufacturing Report highlighted that a number of new materials are currently in development and are expected to penetrate the mass market in the near future. Whilst in most industrial sectors there is a need to incorporate new functionalities into 'classical' materials (e.g., ceramics, metals, textiles, paper) to give them a higher added value[3], the specific property or novel properties of new, advanced materials will provide a competitive advantage in certain application areas through improved performance, enhanced design or through integration into new systems or components. For example,

comparatively new materials such as graphene, carbon and inorganic nanomaterials and novel composites (that have shape memory and self-healing properties) offer significant potential for improving performance, added functionality and increased value in a wide range of application areas including energy storage, consumer electronics, pharmaceuticals and aerospace. This translation, however, introduces a myriad of production and systems integration challenges requiring major advances in new manufacturing processes and technologies.

Addressing the manufacturing challenges in using new and novel materials is part of the 'Frontier Manufacturing' priority within EPSRC's Manufacturing the Future theme. Recent initiatives that explore this include Graphene Engineering and Manufacturing with Light. A complementary area that emerged from the 2011 Frontier Manufacturing retreat (a workshop to scope future strategy for manufacturing research) related to 'Hierarchical Materials'. Here, the participants identified a number of future manufacturing research challenges such as making bespoke tailored materials, manufacturing monolayers and providing a route to manufacturing for nanomaterials. Further discussion and critique on this topic revealed that "there is a need to enhance scale-up of novel materials using design and measurement science as well as to build functionality of novel materials" and that a multi-disciplinary approach would be advantageous.

A recent review of UK Material Science research indicates that the UK has a vibrant research community in materials science and engineering, with specific research strengths in polymeric materials, graphene, energy materials, functional ceramics, theory and simulation and materials discovery and processing into functional devices. The research community has established good links with industry and have become increasingly open to collaboration across disciplines, including physics, engineering and chemistry (which has been demonstrated through significant EPSRC initiatives to support Frontier Materials Manufacturing, Chemical Sciences and Engineering Grand Challenges and Physics Grand Challenges).

To capitalise on the strengths of the UK research base and the growing capacity in functional materials research, there is now a timely opportunity to accelerate the manufacture of advanced functional materials in order to develop and demonstrate viable processing routes, pathways to scale-up and production of application-focused devices and systems.

Scope of Call

This call aims to support research programmes that **enhance the manufacturing aspects of advanced functional materials and accelerate the science through to application**.

The key manufacturing challenges that this call wishes to address are:

- How to scale-up the production and fabrication of advanced functional materials from the laboratory to the plant? (including design of laboratory scale processing techniques that lend themselves to up-scaling at pilot plant level).

- How to improve measurement and control techniques that can ensure or enhance the designed functional properties of a material during manufacture or assembly (particularly when using new processes)?

- How to develop new and bespoke assembly methods that can be adapted to the manufacturing of functional materials and their incorporation into systems?

- How to build on behaviours explored at the nanoscale for larger-scale manufacture? (for example, the up-scaling of promising research approaches explored in 'Nanoscale design of functional materials' Grand Challenge).

Within the context of these challenges, some examples of types of research that could be included into research programmes are:

- Inclusion of multi-functionality into materials design or fabrication through modified or novel manufacturing processes (for a purpose or particular transformational application);
- Scaling-up of laboratory-scale processes leading to the development of prototype functional devices;
- New manufacturing ideas for accelerating the development and production of functional materials;
- Use of novel manufacturing approaches to add functionality into "classical" materials (e.g., ceramics, metals, textiles, paper, building and construction, etc.) that add significant value;
- New manufacturing approaches to metamaterials (i.e. materials with properties not found in nature) that offer the potential for manufacturing scalability and/or improved performance;
- Using innovative surface chemistry or surface engineering principles to enhance novel functionality;
- Functional materials that can be used in additive manufacturing ('printable' functional materials), especially materials and manufacturing approaches to make hierarchical or composite structures;
- Modelling or behaviour-prediction techniques that specifically enhance manufacturing of advanced functional materials;

However, proposals should NOT focus on

- Research into structural/ bulk materials;
- Established functional materials or concepts that are already being developed and progressed towards manufacturing (i.e. there is already a healthy activity on developing devices and products using functional materials such as graphene, silicon fibre, etc…);
- Material science (i.e. synthesis, characterisation and fundamental study of new functional materials).

Funding available

EPSRC will aim to support a number of large, long-term, multidisciplinary research projects (with up to £2.5 million EPSRC contribution per project).

This approach will facilitate a balance between competition and collaboration and allow large teams to deliver on this agenda whilst giving the necessary diversity without excessive bureaucracy and management.

We aim to provide grants for up to five-years with flexible funding (similar to that provided through EPSRC programme grants) that can be used for a mixture of research projects, feasibility studies, networking and outreach activities.

Projects should consist of a suite of related activities built around a central research challenge. The funding will allow the flexibility to change direction during the grant and explore new opportunities as they arise, but there should be a clear decision-making process in place to do this (i.e. by incorporating a management structure from the outset to ensure the objectives of the project as assessed are retained).

In addition to research activities, research programmes should identify with the following key features:

- Draw upon emerging scientific capability in the physical sciences and engineering communities;

- Demonstrate the added value offered by the assembled collaborative team, in particular why the team offers a relevant multidisciplinary approach and brings complementary skills to this emerging area;

- Explicitly consider the pathway to manufacture – including issues of scale-up, design, process engineering and product quality. (*The Catapult Centres supported by the Technology Strategy Board may provide opportunities for further development and/or support the industrial deployment of new material systems).*

- Seek input from end-users or industry where appropriate (for example, to describe how novel functionality will change existing business models). This may imply the inclusion of industry representation on a project steering board or the involvement of specific industrial project partners in the project.

- Adopt a systems approach (both in terms of supply chain and resources, particularly in relation to the energy, material/resource, industrial and economic systems);

- Include a programme of people-based activities to help strengthen the essential cross-disciplinary collaborations, develop new research activities and increase impact in this area. This might include activities such as seminars, workshops, community-building activities, mobility, cross-disciplinary research translators and outreach to industry.

- Help to grow the community in this area to develop critical mass and resonate with the EPSRC strategic goal of Developing Leaders.

Equipment

The availability of advanced instrumentation and equipment can be critical for advanced materials research. However, EPSRC has limited funding for capital equipment. Where possible, researchers are asked to make use of existing facilities and equipment, including scale up facilities which may be available

within the High Value Manufacturing Catapult or other universities (see Press Release for recent 'Capital for Great Technologies' call).

If equipment is needed as part of the research proposal, applicants must consider new rules for requesting equipment over £10,000 in value. Individual items of equipment up to the current OJEU (Official Journal of the European Union) procurement threshold can be included on research proposals submitted through this call, but research organisations will normally be expected to make a contribution to the cost. However, all requests for single items of equipment above the current OJEU threshold should be accompanied by a two-page business case outlining the strategic need for the equipment and how to ensure maximum usage. These business cases will be assessed through a strategic equipment peer review process.

For more information on equipment funding, please see:
http://www.epsrc.ac.uk/research/facilities/equipfunding/Pages/funding.aspx

Eligibility

For information on the eligibility of organisations and individuals to receive EPSRC funding, see the EPSRC Funding Guide:
http://www.epsrc.ac.uk/funding/guidance/fundingguide/Pages/fundingguide.aspx

As this call is a targeted funding opportunity provided by EPSRC, higher education institutions, and some research council institutes and independent research organisations are eligible to apply. A list of eligible organisations to apply to EPSRC is provided at: http://www.rcuk.ac.uk/funding/eligibilityforrcs/

How to apply

There are two stages for this call:

First Stage – Expression of Interest (EoI)

Applicants should complete the Expression of Interest form by the deadline of **16:00 Tuesday 15th April 2014**. Although applications may be multi-institutional, only one form should be submitted per bid. At this stage, we will not accept any other documents such as annexes, a work plan or letters of support.

The electronic EoI form (available on the call website) contains the following sections:

- Organisation where grant would be held;
- Project title;
- Start date and duration;
- Applicants;
- Summary of the research challenge (2000 characters);
- Proposed research programme (5000 characters);
- Summary of resources (including equipment to be requested, if any).

Expression of Interest Assessment

The EoI will be assessed on the following assessment criteria:

- Fit to the scope of the call as described in this document, including the ability to address key features (i.e. draw upon emerging capability, adopt a systems approach, consider pathway to manufacture and input from end-users or industry);
- Potential quality of the proposed research with intended outputs and deliverables;
- Strength of the research team;
- Management structures – a brief outline of management arrangements is required. A project plan is not required at this stage.

An EPSRC panel (with independent academic and industry representation) will short-list the EoIs based on the information provided and by assessing how the research ideas satisfy the criteria listed above.

Applicants of shortlisted EoIs will then be invited to submit a full grant proposal subject to any specific advice or guidance that the panel may recommend to optimise the proposed research and its alignment to the scope of the call.

We reserve the right to reject proposals that are substantially outside the scope of the call or wholly beyond the remit of EPSRC without reference to peer review.

Second Stage - Full proposals

After short-listing the Expressions of Interests, we will invite a number of applicants to prepare and submit full proposals using the Research Councils' Joint electronic Submission (Je-S) System (https://je-s.rcuk.ac.uk/). Further information on how to submit proposals will be provided to successful applicants.

The full proposal should expand on the research challenge and proposed work programme as summarised in the EOI, and also should include:

- Track record of the applicants, justification of the added value offered by the assembled collaborative team and how this grant will complement the group's other activities;
- Full details of the involvement of project partners (e.g. industrial collaborators and other user groups), including contributions being provided by these organisations and their role in transfer of research outputs into policy and practice. Letters of support should be included as appropriate;
- Statement of national importance;
- Statement of pathways to impact;
- Details of ensuring maximum usage for large equipment (if requested);

- Detailed arrangements for project management in terms of milestones and deliverables.

The full proposal should contain a Case for Support including a Track Record, Work plan, Justification of Resources and the Pathways to Impact document. Please add CV's (where applicable) and statements of support from collaboration partners. **If involving more than one institution, the proposal should still be submitted on a single Je-S form. Joint proposals with more that one Je-S form will not be accepted.** If your proposal exceeds the standard page limit or does not conform to this format, your proposal will not be considered. Please note that EPSRC reserves the right to reject a full proposal where the resources are substantially different from those indicated in the EOI form or where there have been other significant changes from the EOI.

For guidance on format and advice on writing proposals see:
http://www.epsrc.ac.uk/funding/guidance/preparing/Pages/writing.aspx

Please note the RCUK policy for equipment procurement and funding of new research equipment will apply to this call, where;

a. Individual items of equipment below £10,000 should be included in proposals for individual research projects and will be paid at 80% FEC. They should be included in Other Directly Incurred costs. If VAT and/or Import Duty do not apply, a value of zero should be entered in these fields.

b. Individual items of equipment between £10,000 and the current OJEU (Official Journal of the European Union) procurement threshold should be included on proposals for research projects. Additional justification and details of the proposed contribution to the cost of the equipment, must be provided in the justification of resources.

c. Individual items of equipment above the current OJEU threshold should not be included on proposals for research projects. Instead, an individual application for these items of equipment must be submitted as a separate proposal, which, if successful through an outline stage, will be judged by a Strategic Equipment Panel. The expectation is that the equipment will underpin the research programme including both existing and potential future research projects.

For full details on equipment assessment, please see the guidance on the EPSRC website:http://www.epsrc.ac.uk/research/facilities/equipfunding/process/Pages/sep1.aspx

Full Proposal Assessment

In addition to ensuring that the programme of proposed research fits within the scope of the call and addresses any recommendations made by the panel (based on the EOI submission), full proposals will be assessed on:

- Quality and excellence of the proposed research including novelty, timeliness, ambition and appropriateness of the proposed methodology.
- National importance and how the research underpins or contributes to manufacturing challenges and emerging industry.
- The pathway to impact and effectiveness of the activities identified to help realise these impacts, including the resources requested for this purpose.
- Applicant ability to deliver the research and balance of skills within the research team.
- Appropriateness of resources requested (including equipment usage or access arrangements) and management plans.

Full proposals will be sent to independent peer reviewers, including at least one nominated by the applicant. The postal peer reviewers' role will primarily be to comment on the quality of the research. Those with sufficiently favourable reviewers' comments will be asked to respond to the reviewers' comments and then invited to an panel interview.

This panel, consisting of independent assessors, will collectively consider and rank the proposals against the full assessment criteria, based on the reviewer comments, PI response and overall interview performance. The panel will then make funding recommendations to EPSRC. We will send further details on this process to applicants following the first stage (with the invitations to submit full proposals).

As with standard grants assessment, any equipment requests over the current OJEU threshold that accompany research proposals will need to be assessed separately by an EPSRC Strategic Equipment Panel.

Further Guidance

Information about the EPSRC peer review process and guidance for reviewers can be found at: http://www.epsrc.ac.uk/funding/peerrev/Pages/peer.aspx

Additional grant conditions

In addition to the standard terms and conditions for grants, successful applicants will be required to have a signed collaboration agreement in place before the grant starts (if external collaborators are included in the grant). There will also be a requirement for the investigators to carry out a mid-term review of the activities funded through the grant.

Key dates

Activity	Date
Call launched on web (EOI stage)	11 February 2014
Closing date for EOIs	16:00 15 April 2014
Short-listing panel	Early May 2014
Applicants invited for full proposal	Mid-May 2014
Closing date for draft equipment business case	4 June 2014
Closing date for full proposals	End July 2014
Postal peer review	Aug-Sept 2014
Assessment (interview) panel	End October 2014
Grants Announced	December 2014
Strategic Equipment Panel	January 2015
Expected Start Date	1 February 2015

Contacts

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Change log

Name	Date	Version	Change
Andy Lawrence	29 Jan 2014	1	N/A

Name	Date	Version	Change
Andy Lawrence	3 Feb 2014	1.1	Modify call text
Andy Lawrence	5 Feb 2014	1.2	Update links, text and key dates

References

[1] http://www.wsts.org/PRESS/Recent-News-Release
[2] http://www.researchandmarkets.com/research/shcl5q/advanced
[3] Materials for Key Enabling technologies (ESF/ EMRS Report 2011)