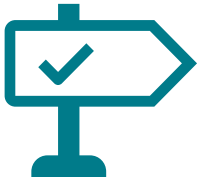
Research and development case study

National Audit Office

Advanced materials research

November 2017

Introduction



This case study on **advanced materials research** is one of a series that we have developed to support and complement our published report on research and development.

Our examination of advanced materials research focused on arrangements to coordinate the funding of research into the invention of novel and advanced materials and their applications.

Other case studies focus on research relating to:

- animal and plant health;
- climate;
- energy;
- human health; and
- robotics and autonomous systems.

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Summary

1 Who is involved?

Funders, coordinators, researchers, influencers

2 What happens?

Stages of research activity

Video
The real world view: advanced materials research

3 How much is spent?

The Engineering and Physical Sciences Research Council (EPSRC) is the main public funder of advanced materials research; the government currently invests around £0.6 billion in related research programmes

4 What did we find?

Some evidence of coordination mechanisms but an absence of strategic leadership and coordination, coupled with an absence of consolidated information to inform decisions and evaluation

- Government has faced challenges in establishing stable leadership arrangements in advanced materials
- The Ministry of Defence (MoD) has established a network for sharing information on research activities, skills and knowledge related to materials applications in defence

1 Who is involved?

The funders

- UK government departments (including the MoD)
- Research councils (including the EPSRC)
- Innovate UK
- Industry (including aerospace, automotive and construction sectors)
- European Union

The co-ordinators

- EPSRC Materials Exchange Research Forum
- Innovate UK's Knowledge Transfer Network
- Catapults (including High Value Manufacturing Catapult and its associated specialist centres)

The researchers

- Research institutes (including the Sir Henry Royce Institute for Advanced Materials)
- Universities
- Industry
- International

The influencers

- Policymakers and parliamentarians
- Learned societies (including the Royal Academy of Engineering)

2 What happens?

Stages of research activity

Description of research	Basic	Applied	Translational
Purpose of research	**Knowledge expansion** – asks questions about materials and their properties. Research is approached as a scientific study rather than to address specific needs	**Solutions-focused** – research is concerned with finding a solution in response to a specific question or problem	**Product development** – takes the findings from basic or applied research and uses them to develop new products and treatments
What is involved?	Experiments by academics and researchers at university laboratories or research institutes	Testing and observation of materials at demonstrator facilities	Development of new products at demonstrator site facilities
Funders include	Government departments; research councils; higher education funding councils; industry	Government departments; research councils; higher education funding councils; Innovate UK; industry	Innovate UK; industry
Examples of successes	**Graphene** – EPSRC-funded scientists worked out how to isolate graphene during experiments. Because of its multi-functional properties, graphene can be used in thousands of different applications.	**Superconducting materials** – scientists have developed a tape made from carbon dioxide that can conduct 100 times more electricity than copper. Use is currently restricted to small-scale projects but the expectation is that the technology can be further developed with many applications to day-to-day electronic devices.	
Examples of current programmes and projects	**Materials discovery** – one of the core research areas at the new Sir Henry Royce Institute for Advanced Materials is materials discovery. This focuses on manufacturing resource-efficient materials and exploring light-weight materials, with the ultimate objectives of developing prototypes and scaling up production.	**Materials for the housing market** – an EPSRC-funded project is looking to build on the success of earlier research and develop new transformative construction materials including the first self-healing concrete trials using new materials technologies.	**High temperature aerospace materials** – development of higher-temperature advanced alloys that will improve the efficiency of gas-turbine engines, resulting in reduced fuel consumption and reduced emissions.

3 How much is spent?

Who are the principal funders?

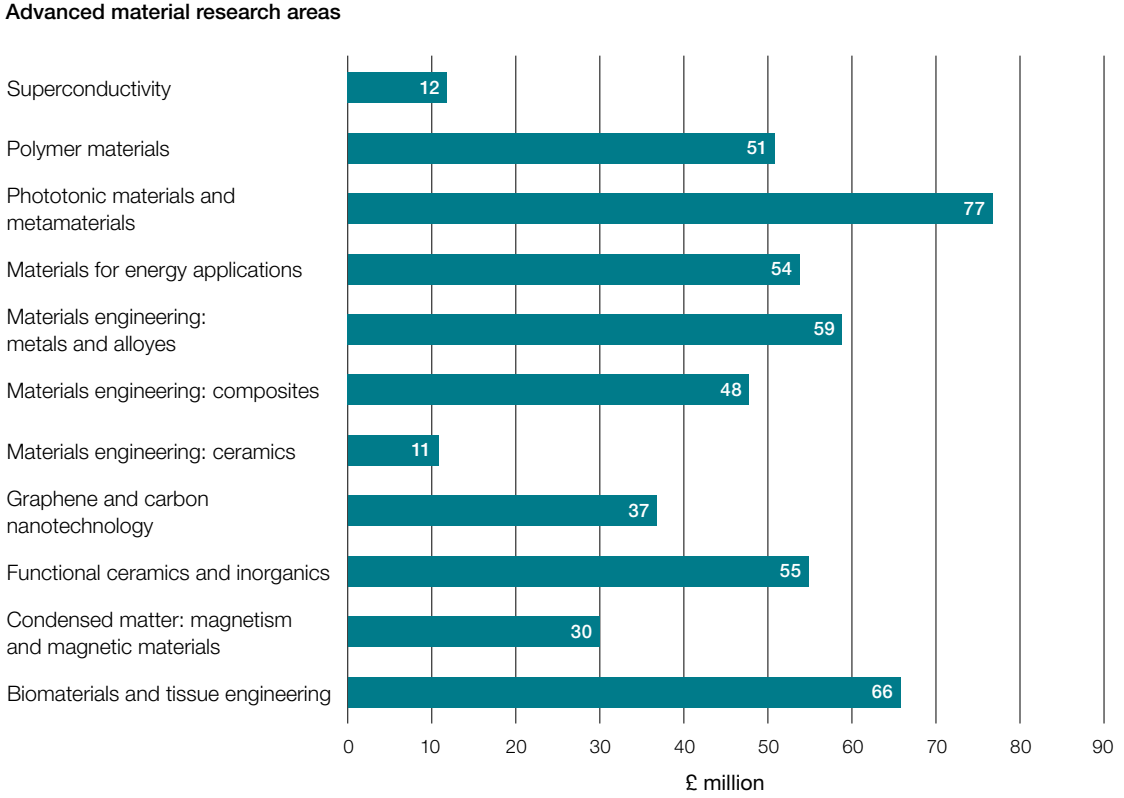
Advanced materials research covers a wide range of research areas. The EPSRC has identified 11 research areas as being central to advanced materials research.

EPSRC is the main government funder of advanced materials research. As of March 2017, **its current funding of research projects in these areas totals £500 million**, mainly collaborative projects between academia and industry.

The MoD invests in its Materials and Structures Technology (MAST) programme, a core research programme to acquire knowledge and find solutions to specific problems. In 2016-17, the **MOD's planned expenditure on the MAST programme totalled £6.5 million**.

Innovate UK planned to spend **£137 million on its Manufacturing and Materials programme** in 2016-17.

EPSRC's current or 'live' investment in advanced materials research (March 2017)



Source: Engineering and Physical Sciences Research Council, *Research portfolio database*, March 2017. We undertook a customised search of the database to identify funding data on the 11 research areas highlighted as central to advanced materials research.

4 What did we find?

Government has faced challenges in establishing stable leadership arrangements in advanced materials

The government established the Advanced Materials Leadership Council (AMLC) in December 2014 with the objective of:

- bringing together leaders from government, industry and academia to develop a strategic vision for advanced materials;
- enabling accelerated development of advanced materials applications for the benefit of the UK economy;
- providing strategic advice to inform government policy; and
- ensuring that there is underpinning investment in skills, resource and capital.

The AMLC published a strategic vision for advanced materials and a series of papers on four areas (energy, health, electronics and demanding environments) where it identified that there were specific opportunities for new investment. It observed that, while there have been huge advances in a wide range of materials applications, there are few examples of successful exploitation. It further noted the absence of a vision and clear direction to capitalise on the full potential of UK industry.

However, the Leadership Council was dissolved in December 2016 and it was not clear at that time what would replace it. It was then reconvened in June 2017 as a smaller group chaired by a representative from industry. The new group aims to be more responsive and flexible than its predecessor and its specific task is to advise on where financial interventions will have most impact. The Leadership Council will have an initial lifetime of 12 months after which it will be reviewed for impact.

Creating stable leadership arrangements for advanced materials presents challenges as it is not an easily defined area of research: it encompasses many different research disciplines and underpins various technological applications. But government leadership and engagement with others is needed to tackle barriers to collaboration, identify opportunities and challenges, develop a coherent investment strategy and maximise the value of government's investment in research.

4 What did we find? *continued*

The Ministry of Defence has established a network for sharing skills and knowledge on materials applications in defence

- The Defence Materials Forum was formed around ten years ago to establish a community and share skills and knowledge.
- The Forum brings together suppliers from academia and industry (multi-nationals and small and medium-sized enterprises), defence intelligence and security, government departments, the research councils and Innovate UK.
- It meets every six months in different UK locations to bring different groups together.
- Its meetings build the MOD's understanding of external capability and help it monitor developments in the supplier base. While the focus is on military applications, the participants work in both civil and military sectors.
- The agenda includes technical presentations, ongoing work, funding opportunities and networking events. The Forum raises awareness of available funding opportunities and links funders and developers with exploiters.
- In addition to the Forum, the MoD's subject matter experts interrogate databases (e.g. the Research Councils' Gateway to Research) and use software to find out about collaborations and research in the civil sector.

Case study of civil sector technology adapted for military applications: using ceramic technology to make body armour

- Subject matter experts at the MoD were aware of academic research into the use of ceramic technology.
- The MoD's MAST research programme funded a project to develop the materials and processes necessary to produce curved body armour. The technology, usually used for commercial kiln furniture, was successfully adapted to develop an economical way of making lightweight body armour plates for soldiers (30% lighter than existing equipment).
- The ceramic armour technology is now commercially stable and the company that developed the material is bidding for overseas contracts to supply body armour and kiln furniture.

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