COUNCIL FOR SCIENCE AND TECHNOLOGY

# Science Landscape Seminar Reports: Advanced Materials

## Background to the meeting

This seminar is one of a series convened by the Council for Science and Technology (CST), which is working to provide a map of the UK Knowledge Landscape as a whole. This mapping includes all areas of research carried out by academia, industry, charities and others.

The seminar series has brought together diverse sets of experts to discuss eight parts of the research landscape in depth; these areas are roughly aligned with the UK government's eight great technologies.

The aim of this work is to provide decision makers with a clearer picture of the whole landscape and enable better strategic decisions to be made. We would also like the reports to prompt communities to think more about what they can do to ensure their areas continue to make the best case for themselves and operate in a coherent way. The seminar series is limited in scope, but has revealed the importance of a clear articulation of the strengths and requirements of different parts of the UK research landscape. Specific research communities may wish to hold further sessions of their own.

The discussion took place under the Chatham House rule. This document represents the views of this group and is published alongside an infrastructure resource (see below) which reflects the seminar's view of the Advanced Materials landscape.

This meeting addressed Advanced Materials research and development, and was asked to consider:

- Strengths and weaknesses of Advanced Materials research in the UK;
- How the UK compares internationally; and
- What future concerns exist for the discipline.

## 1. Infrastructure list

To seed discussion, attendees were provided with a draft list of infrastructure relevant to Advanced Materials. The list is not exhaustive but does provide a summary of some of the key facilities for Advanced Materials research in the UK. It was updated in the light of discussion at the seminar to include, for instance, a section to reflect the importance of SMEs in this area and some key international facilities. The infrastructure list is available at: www.gov.uk/government/publications/science-landscape-seminar-advanced-materials.

## 2. Scene setting

In discussion, it was agreed that the Advanced Materials landscape is difficult to fully capture. There is only a loose boundary around what is included in this area of research and a range of other disciplines, such as energy storage, nuclear power and electronics are underpinned or significantly supported by Advanced Materials research. This can make it hard for the discipline to articulate clearly the challenges the discipline should focus on. The Knowledge Transfer Network (KTN) and EPSRC are doing work to improve the messaging on, and co-ordination of, Advanced Materials research. The formation of the Advanced Materials Leadership Council will be helpful in providing a focal point for internal discussion and developing both strategy and co-ordination around the grand challenges in the area.

There is also an important point to be made about the different magnitudes of improvement that are possible in different areas of Advanced Materials research. In some sub-disciplines, incremental improvements can be extremely valuable, such as the development of heat-resistant materials for aerospace engines. In others, developments come in the form of step-changes, which provide revolutionary improvement. Both of these processes are valuable in their own right but it is important to choose the right mechanism for improvement and not to chase fads or to settle for gradual improvements respectively.

## 3. Strengths and weaknesses of the UK system

The UK is acknowledged as strong in Advanced Materials research. Key strengths identified by the seminar were as follows:

- Modelling, and in particular code development. This brings benefits in reducing the time to market for new products, which is a crucial factor in successful development. However, we don't always have the testing capability to validate new models. As a result, some of the benefits are realised abroad rather than domestically.
- The UK's University sector. This is considered very strong in both the invention and discovery of new materials.
- Characterisation of materials, the process by which a material's structure and properties are probed and measured.
- Pre-competitive collaboration by industry in the UK is generally done well and, although more could be done, companies do work together across sectors to solve common problems.

Despite these strengths, seminar participants identified some key weaknesses and concerns regarding the future of the discipline:

- There is currently a danger that some parts of materials research are hindered by a skills shortage. This was particularly highlighted in metallurgy. *(See section 3.1 below)*
- There is a concern that the infrastructure currently available in the UK could be more efficiently used to provide additional benefit. *(Section 3.2)*
- There is currently a high level of investment by other countries that have a strong emphasis on research *and* application skills. China and the U.S. in particular are prioritising Advanced Materials research. Korea and Germany also have significant long-term programmes. *(Section 3.3)*

- Electronic materials, in particular large-scale silicon technology, is currently an area in which the UK is weaker and one in which, for example, China is particularly active. There needs to be realism in choosing areas where the UK can be world-leading in the very wide range of areas covered by Advanced Materials research. This means understanding where competition from other countries is very intense and what the return on investment is likely to be.
- The UK is often better at theoretical than practical materials science. A prime example of this is small scale testing under extreme conditions, testing coatings and joins, where industry often looks abroad (US, Germany, Switzerland) to fulfil its needs. This problem is also relevant to nuclear materials; industry and academia lack testing facilities in the UK and sometimes have difficulty in accessing facilities located overseas.
- Our understanding of how materials age could be improved, particularly with regards to sustainable materials. The current uncertainty can cause a tendency to place a high weighting on upfront investment and not give enough consideration to "through-life" costs. This can impact on procurement decisions.
- There is some concern that materials research, in particular the use of new materials, is sometimes hindered by regulation; it is key to involve the regulatory agency as early as possible in the development process to help mitigate this.

Three areas of concern were discussed in more depth and the points made by seminar participants are expanded upon below:

## 4. Skills

- The need to encourage young children (including at primary school) to study STEM subjects at GSCE and A-Level. The Institute of Materials, Minerals and Mining (IOM$^3$) do good work on this promotion.
- Skills shortages are particularly acute in lower profile areas, such as metallurgy, forcing some organisations to train in-house. The relevant disciplines need to build confidence and researchers must believe that they can make key breakthroughs in order to attract the brightest graduates.
- It may be helpful to frame the discipline in terms of the problems that it can solve in order to convey its importance. Recycling, de-manufacturing of materials and energy related materials are all areas that could be particularly attractive to graduates, because of the sustainability issues they address.
- Advanced Materials research also suffers from a lack of diversity in the skills base, with very low involvement from women and ethnic minorities. However, it should be noted that this issue is also present in competitor countries.
- Nevertheless, there are research areas in which the UK has a strong skills base, notably nuclear materials and modelling of materials, where centres in Cambridge and Liverpool are seen as world leading.

## 5. Infrastructure

- Using our facilities to their full capabilities is crucial. This means round the clock use. Organisations and individuals need to ensure that they have prepared fully, prior to booking.
- Due to the costs involved and the specialist knowledge required, large infrastructure is often more accessible to large industry. However, it is important that SMEs are provided with the resources required to access and make efficient use of this infrastructure.

## 6. International competition

- There is a risk that, if domestic infrastructure is not available, UK research is exploited abroad. This means that the UK may not realise the full benefit of its own research and facilities. There are already companies who have made a choice to go to the US or Germany to do testing of products developed in the UK, due to a shortage of facilities here.
- Although the quality of fundamental science is generally strong in the UK, some other countries, including South Korea, were considered by seminar participants to be more strategic in some areas, allowing them to direct the course of research more effectively.
- The UK should develop a clear strategy that enables and facilitates effective funding decisions with a clear overall direction, rather than attempting to hand-pick isolated “winners”. Such a strategy will be strongest if it engages government and industry as equals, to ensure the UK remains able to take advantage of its high quality science at the global scale.

## 7. Industry and academia collaboration

A number of issues were raised:

- Industry is a particularly key player in the area of Advanced Materials and funds large amounts of research through grants, private research and numerous industry and university collaborative centres. The result is (generally) good collaboration between academia and industry. However, opportunities do exist for SMEs and academia to collaborate further.
- Collaborative centres help to ensure that materials are developed with a manufacturing ethos in mind and that science is pulled through to the manufacturing process. The presence of high-quality scientific research at all Technology Readiness Levels (TRLs) is just as important as industry involvement in the early stages of research.

## 8. Future priorities

Seminar attendees discussed future priorities for Advanced Materials. They highlighted a number of issues, including the need for:

- The discipline to speak with a coherent voice, define itself clearly, and form clear strategic plans for the future.

- Further work on the recycling and de-manufacturing of materials. This is predicted to be an issue that will grow in importance over the next 10-15 years. It is also an issue with the ability to draw in bright graduates, due to the nature of the problems that this research will attempt to solve.
- Continuity and stability to be maintained with regards to capital funding to ensure a stable platform upon which industry can invest with confidence. Continuity of funding also allows research to work through a problem in its entirety, rather than only taking small individual bites.

The formulation of a new Leadership Council in Advanced Materials has the potential to help address some of these issues. The Council should seek to help the expertise in the UK speak with a unified voice, most effectively galvanise industry investment and facilitate maximum collaboration between industry, academia and government.

This publication available from www.gov.uk/cst

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