Royal Society's response to an initial consultation by the Royal Commission on Environmental Pollution on its new study on the environmental effects of novel materials and applications

1 Overview

Ensuring the responsible development of new and emerging technologies, and particularly the role of the scientific community in this challenge, is of importance to the Royal Society. We therefore welcome this new study by the Royal Commission on Environmental Pollution (RCEP). As the RCEP is aware, the joint Royal Society/Royal Academy of Engineering report on nanoscience and nanotechnologies (Royal Society & Royal Academy of Engineering, 2004) covered a broad range of novel nanomaterials and applications and their health, safety, environmental, social, ethical and regulatory implications. This response draws on the results of that study as well as drawing on comments from experts in other fields. We would strongly support the RCEP taking a life-cycle approach in its new study. In addition we suggest that it considers: impacts within the broader policy context, whether the UK has adequate incentives to encourage novel materials and applications that have a net benefit to the environment; what role those involved in the research and development of novel materials and applications (both in the academic and industrial sector) should play in identifying potential hazards; and the appropriate research and funding models for delivering the research needed to underpin the regulation of novel materials and applications. We would be happy to provide further comments to the RCEP or to suggest experts that they might contact as they develop their study further.

2 Scope of project

The scope of this project is currently very broad and there is a wide range of materials and applications that the RCEP might consider. These include biological products and processes (eg increasing industrial use of enzymes in biotransformations) in addition to inorganic materials. RCEP could narrow its study in one of the following ways:

- Briefly review the range of novel materials and applications expected to figure in the next 10-15 years and then take an issues-based approach, selecting appropriate novel materials and applications as case studies. However this will still be a very large task.
- Focus on products that involve the release of large quantities of the novel material to the environment - either directly (eg major releases of free nanoparticles to the environment for bioremediation) or where the products in which novel materials are used are likely to be produced in very high numbers (a historical example of this is the extensive use of carbon fibres in aeroplane in the 1960s; these are now being scrapped).
- Focus on a particular type of novel materials or applications that have received little attention to date. The example of rare earth metals that are used in a wide range of optical, magnetic and electronic devices was given by one of the experts that we consulted. The issues relating to these metals include the environmental impact of extracting and separating the metals from their ore and their fate at the end-of life.

In narrowing down the scope it will be important to seek input from the industrial sector regarding likely developments in the exploitation of novel materials and applications.

3 Identifying positive and negative impacts

We are pleased that RCEP is looking at both the positive and negative environmental impacts of novel materials and applications. It is clear that the possible environmental benefits of novel materials and applications are wide ranging, including the reduction in use or replacement of harmful chemicals, energy efficient production methods, non-fossil fuel sources of electricity and remediation of polluted areas.

However a comprehensive and transparent impact assessment approach is required to evaluate claims about environmental benefits, for example to evaluate whether savings in resource consumption during the use of the product are offset by increased consumption during other stages of the process (eg in manufacture/extraction or end of life). In addition to the life-cycle analysis approach identified by the RCEP, the impacts of novel materials, processes and applications should be considered within a broader policy context. For example exploitation of novel materials and processes should be considered within the context of sustainable production, consumption and procurement policy over the short, medium and longer term and at the UK, EU and international level (eg. the study could consider what pressures will be placed on natural resources as a result of increasing demand for novel materials and how these will interact with other pre-existing pressures such as over-exploitation, pollution etc).

RCEP might also like to consider whether the UK has adequate incentives to encourage the application of novel materials and applications that are beneficial to the environment. In the US, the Environmental Protection Agency (through the Science to Achieve Results program) has committed more than $11 million to research into applications of nanotechnology to protect the environment including the development of methods of removing toxic contaminants from surface water; sensors with an increased sensitivity to pollutants; green manufacturing of nanomaterials; and more efficient catalysts.

In comparing the risks and benefits of novel materials and applications it is important to recognise that medical or commercial benefits (eg the electronics industry) are easier to quantify in financial terms than environmental costs. Unless appropriate incentives are in place, this can result in commercial interests outweighing those of the environment. We suggest that RCEP explore whether decision making frameworks can be developed to ensure that equal weight is given to each sector, and to facilitate transparent decision making where trade-offs between sectors are required.

4 Life-cycle analysis

As indicated in the previous section, we strongly support RCEP focusing on the life-cycle analysis of novel materials and applications. It was a key theme of our report on nanotechnologies. The identification of possible risks of novel materials and applications depends on a consideration of the life-cycle of the material being produced. This involves understanding the processes and materials used in manufacture or extraction, the likely interactions between the material and individuals or the environment during its manufacture and useful life, and the methods used during its disposal. We think that the end-of-life phase is particularly worthy of consideration, especially given increasing focus on this at the European Union Level (eg extended producer responsibility Directives). Although RCEP may want to focus primarily on the UK, we believe that the environmental impacts of UK activity both here and overseas should be considered (eg where raw materials are being procured from overseas).

In the case of nanoparticles, we were concerned that some parties were highlighting the exciting new properties of nanomaterials that were being exploited while either failing to recognise or acknowledge the

possible impacts of these properties on their toxicity. In its study the RCEP might consider whether current structure(s) for identifying and dealing with negative impacts of novel materials and applications across the life-cycle is adequate. In particular, RCEP may wish to examine the role that those involved in the research and development of novel materials and applications (both in the academic and industrial sector) should play in identifying potential hazards.

5 Toxicity and ecotoxicity

The key issue under this heading is whether existing tests of toxicity and ecotoxicity are adequate for novel materials (or their decomposition products) and, if not, whether the development of new tests can keep pace with the commercial exploitation of novel materials. The potential for novel materials to persist and bioaccumulate is of particular concern and it will be important to consider whether the simple persistence and bioaccumulation models (as outlined in the RCEP's 24th report – RCEP, 2003) are appropriate for novel materials. In the case of nanoparticles there is virtually no information available about how they behave in the air, water or soil or their effect on species other than humans. We found that essentially the only information on how they are transported through environmental media such as soil and water comes from initial studies on their potential for remediation. There may also be difficulties in detecting and monitoring novel materials in the environment.

6 Research funding & structures

We have already highlighted funding schemes in the US aimed at developing the positive applications of novel materials and processes (section 3). As part of its study, the RCEP might like to investigate the appropriate research and funding models for delivering the research needed to underpin the regulation of novel materials and whether this research is keeping pace with the development of novel materials. In some cases there will be a need for a certain amount of capacity building to develop a core of researchers that have expertise in this area and that can engage in international research programmes. In addition, it is clear that the required research will demand an interdisciplinary approach.

As in the example of nanoparticles used for bioremediation quoted above, important information about the fate and behaviour of novel materials in the environment could be gained from researchers seeking to exploit them. In the case of nanomaterials, we recommended the establishment of an interdisciplinary centre (perhaps from existing research institutions) to undertake research into the toxicity, epidemiology, persistence and bioaccumulation of manufactured nanoparticles and nanotubes, to work on exposure pathways and to develop measurement methods. The centre would bring together those developing nanotechnologies with those investigating their impacts and would liaise closely with regulators. We have been disappointed with the Government's response to this aspect of our report. We believe that too much reliance is being placed on responsive mode funding to deliver research that is essential to underpin regulation.

7 Regulation

We emphasise above the importance of ensuring that the regulatory framework is underpinned by research into the risks of novel materials and applications. We believe that a consideration of the regulatory framework should be part of the RCEP's study. The detailed regulatory review instigated by the government in response to our report on nanotechnologies could be a useful input to the RCEP study.

8 References

Royal Commission on Environmental Pollution (2003) Chemicals in products safeguarding the environment and human health, 24th Report. Her Majesty's Stationery Office: London

Royal Society & Royal Academy of Engineering (2004) Nanoscience and nanotechnologies: opportunities and uncertainties. Policy document 19/04. The Royal Society London.

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