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SMART Perspectives of European Materials Research

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Purpose

Modern materials sciences take as their objective to develop and tailor materials with a desired set of properties suitable for a given application. Next to conventional approaches, predictive modelling and simulation is more and more used. This results into a rapidly increasing knowledge base, allowing for more precise experimental set-ups, more precise simulations and tailoring of goal-oriented materials. They play a key role in the value chain and in product innovation. Although limited profits are made from materials, materials are technology enablers for new high added value products and therefore a key in innovation acceleration. More success and increased opportunities for applications is the outcome. The SMART project aimed at providing support for future strategic decisions in this sector to foster the strengthening of the European Research Area.

Which Future?

SMART is a Specific Support Action within the 6th European Framework Programme which aimed at mapping of future materials research topics and excellent research groups throughout Europe. Data screening, interviewing and the workshops in the SMART project have shown that Europe has a strong and internationally competitive position in materials research. However, even though materials technology is in a good position today, some weaknesses of the European materials innovation system identified in the SMART could become a risk in the future, if no action is taken.

Forecast and Foresight

A parallel concept is at the core of the SMART-strategy in which both a traditional forecast and an innovative foresight are applied (see Figure 1). The SMART process can be divided into several stages. The first stage involved data screening on the forecast side and identification of relevant studies

on the foresight side. In the second stage expert interviews and analysis of studies led to further progress. In the third and final stage the roadmapping exercises combined both the forecast and foresight results by three thematic workshops.

Socio-economic Topics and 'Technical Pillars'

Industrial Sectors are Dependent on High-tech Materials

Materials innovations are an important part of the cultural European heritage. This can best be seen at the typical European Design. Today, competitiveness on materials innovation is still of utmost important for the following industrial sectors:

- Automotive industry
- Aerospace industry
- Chemical industry
- Electronics
- Textile industry



- Energy technology
- Medical technologies

- Construction
- Defense & security

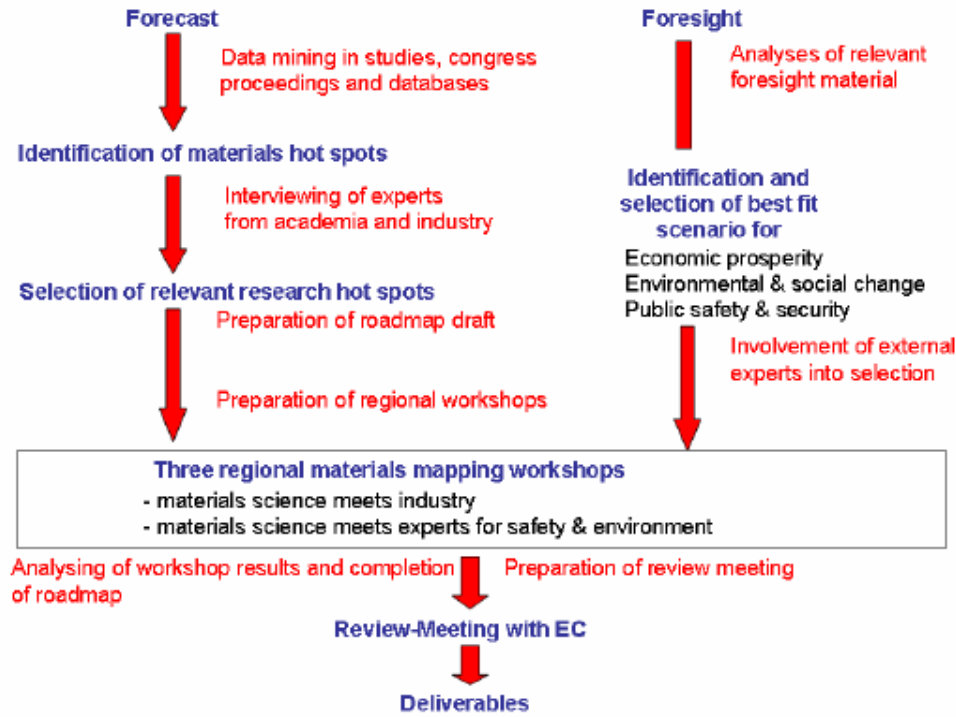


Fig. 1 SMART process

During the course of stage one, 40 foresight studies were evaluated regarding the most important general topics in politics and society and most mentioned material hot spots.

There have been three roadmaps completed in the SMART exercise. For details please turn to the Final Report of SMART or the SMART website (see Source and Link section below). From these completed roadmaps there are three socio-economic areas where new materials will have a market effect: energy, safety and security, and better life (including health-care). They will be highly impacted by the three material topics: Sensors, modelling capabilities, and nanotechnology.

Energy

Production, use, conservation, and management of energy across Europe are top priorities for the future economy. Improved communication across the different energy producing sectors is called for since they all have similar problems. Another issue is the search for potential routes to zero carbon dioxide energy generation through solar technologies and fusion techniques.

Energy conservation for housing will benefit from developments in nanotechnology, for example, with sensors and novel

coatings to minimize energy loss and store energy that is generated by individual houses.

Security

There is an increasing requirement for security in public infrastructures, buildings and communications, which will give rise to innovative security and safety technologies like sensors and sensing materials. Materials developments will play a major role in both personal protection and proof of identity. For the future progress in the security use of RFIDs, the further developments of advanced polymers for printed electronics are needed.

Quality of Life

The enhancement of quality of life of Europeans is an ever continuing challenge. Employment, ageing, health and the participation of disabled people in everyday life are only some of the issues that must be addressed. For this broad area, focus has been on biomaterials, packaging, and technical textiles. Even though materials technology has been developing continuously since ancient times, today's technological materials compare poorly with the performance of materials created by nature. Biomimetics is a class of materials that has the potential for revolutionary innovations.

R&D Policy Actions Required to Consolidate Europe's Position

There are a couple of key issues raised in the SMART results which have particular relevance for policy-making: on EU level as well as on national levels. The national level, however, was not pointed out in mere detail. Thus, recommendations given here are addressed to EU authorities. Some of these seem fairly plain; the challenging part is to actually tackle them.

- Secure Europe's strong position in materials technology by setting up strategic **win-win co-operations with international key players**.
- Strengthen the **public awareness** of materials as being part of Europe's cultural heritage. This could be achieved by actions in the fields of public events, providing materials for education in schools and setting up innovation platforms with fashion makers, architects, designers and human scientists.
- Increase R&D activities in materials technology in the fields mentioned below as well as those in strategic research agendas of specific **European Technology Platforms** by intensive funding, private-public partnership and ensuring R&D friendly regulations.
- Make Europe an el dorado for **excellent materials researchers** on the international level by young scientist competitions, excellent infrastructures and public awareness of their research.
- Further develop the ERA in materials research through **ERANETs, European networks and platforms**.
- Further develop **technology transfer concepts** and strategic research agendas to keep Europe on the edge of technological developments.
- Improve integrated developments approaches through all parts of the innovation pipeline. Increase the number of **joint actions** with research fields like **ICT, life science, mobility and health**.

Materials technology is in a good position today, however some weaknesses of the European materials innovation system identified in the SMART could develop to a threat in the future, if no action is taken.

More Visibility of European Research Results Needed

The visibility of European research results in publications especially in overarching publications like review papers is too low compared to the quality of the research results. The citation rate of most European materials science papers is relatively low compared to other regions in the world. Therefore scientific marketing strategies have to be developed.

Excellence in Basic Research is only One Step toward the Top Position

A traditional problem of European materials research is the fact, that Europe is excellent in basic research but that technology transfer rates and time to market have to be improved. The transfer of many industrial R&D activities to Asia as well as counterfeiting of innovative developments is a real threat to the European materials innovation system.

Long-term and Reliable Research Funding

Researchers expect predictable long-term funding strategies. The 7th European Research Framework Programme (FP7) is an important step towards predictable long-term developments. Since materials are taking up an adequate part in the FP7 in the Specific Programme Cooperation within the theme 4 *Nanosciences, nanotechnologies, Materials and new Production Technologies (NMP)*, excellent conditions for a continued successful development of European materials technology are given. For the first time the European Commission will also support fundamental science in the Framework Programme and established the so called European Research Council (ERC). The ERC could give excellent researchers a European perspective.

Simplifying Bureaucracy

Recently the European Commission started activities to reduce bureaucracy by simplification. Simplification actions have been taken in all political sectors and therefore also in the area of research and innovation. It is still unclear, if the right steps to reduce bureaucracy have been taken and a lot more effort is needed. In the area of European materials research funding the Commission introduced a two stage proposal submission system and reduced the number of funding instruments. This should help to minimize oversubscription and give applicants a clear orientation.

Strategic Decision Making and Innovation Transfer

Crucial for the success of the European materials innovation systems are the right decisions about relevant up-coming research topics and actions to improve technology transfer. There are many relevant European foresight activities in materials science. Cooperation between different strategic materials activities such as European Technology platforms EUMAT, SUSCHEM, Forestry Platform, the Steel platform and materials relevant ERANETs like MATERA, Chemistry and ACENET should be further improved to obtain a dialogue process about the future of European materials R&D. First attempts have been made by setting up the network Material-euroRoads, a dialogue platform for materials foresight experts, and the MATERA outlook Conferences.

Another very crucial question is how to improve the number of successful technology transfers, the time to market and how



to ensure that legal rights are not violated outside Europe. Many different actions have been started in the past in this area, finding an efficient working solution will be a critical success factor for European R&D in materials technology.

Materials Research Priorities

For the three identified socioeconomic inputs where Materials Research can contribute heavily, the identified research priorities for materials are listed below. The specific bottlenecks identified regarding these research topics are pointed out in the final report of SMART (see Reference and Link section).

Energy

Energy is a strategic resource for industrialized countries so that the development of future energy technology is of great importance for Europe. Energy safety and CO₂-reduction are the main drivers in this field. The following research priorities are among those that were identified:

- Innovative gas separation membranes for CO₂-capture technology
- materials for white light emitting devices
- polymers and materials processing for organic light emitting devices
- CO₂-reduction in mobility: light weight alloys, nanocomposites and biocomposites
- materials for superconducting devices
- advanced corrosion resistant (less degradable) materials for various renewable energy sources
- energy storage materials
- advanced joining techniques for manufacturing of wind generators
- ceramics for solar power tower technology
- materials for 3rd generation solar cells

Security

Materials for security applications are not at the forefront of security research, materials research can pave the way for a wider application of sensor technologies through the development of advanced sensor materials for detection systems with increased sensitivities and selectivity as well as for ease of manufacturing. Materials research could also be an important factor in making these technologies widely available.

Smart materials, polymers and nanomaterials are on the way to revolutionizing security technology in the areas of protection by innovative armour and in the field of anti-counterfeiting. Because threats of terrorism, various peace-keeping missions world-wide and anticounterfeiting of European products are relevant areas for European politics, materials research priorities are:

- smart materials and nanomaterials research for protection as well as for the development of sensors to improve the security of European citizens and peacekeeping forces
- advanced polymers and nanomaterials for anti-counterfeiting systems to secure Europe's global market position in high added products.

'Better Life'

Among the identified research SMART priorities in the area of *Biomaterials and Materials for Medical Applications* are the following:

- surface modification technologies for producing innovative multifunctional coatings on implants
- new production technologies for smart materials
- stimuli responsive materials (esp. SMP) for smart surgery tools and high-tech artificial implants
- materials for adaptive drug-device combinations
- basic research on heterogenous materials interfaces for prosthetics to enable disabled citizens a better participation in social life

Materials Packaging

The identified materials research tasks are:

- nanotechnological improvements of packaging materials
- improving the materials performance of bio-based polymers
- intelligent polymers for printed electronics
- sustainable materials for smart packaging

High Tech Textiles

Materials research priorities in the area of high tech textile materials are:

- intelligent polymers for smart textiles
- nanotechnological improvement of technical textiles

Sources and Links

- Schumacher, G.; Preston, S.; Smith, A.; Sajgalik, P. et al.; Future Perspectives of European Research, expected Sept. 2007
- www.materialeuroroads.net

- www.smart-ssa.net

for roadmaps:

- www.smart-ssa.net/c3/index.php?index=22

About the EFMN: Policy Professionals dealing with RTD, Innovation and Economic Development increasingly recognize a need to base decisions on broadly based participative processes of deliberation and consultation with stakeholders. One of the most important tools they apply is FORESIGHT. The EFMN or European Foresight Monitoring Network supports policy professionals by monitoring and analyzing Foresight activities in the European Union, its neighbours and the world. The EFMN helps those involved in policy development to stay up to date on current practice in Foresight. It helps them to tap into a network of know-how and experience on issues related to the day to day design, management and execution of Foresight and Foresight related processes.