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Technology Roadmap High Performance Metals 2020

EFP Brief No. 205

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Sponsors: Federal Ministry for Transport, Innovation and Technology (BMVIT)
Type: Single Issue

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Duration: 07/2008–11/2009 **Budget:** € 150,000 **Time Horizon:** 2020 **Date of Brief:** Nov 2011

Purpose

To establish a basis for informed decision-making, the BMVIT, the Austrian ministry for traffic, infrastructure and industry commissioned the creation of a technology roadmap for high performance metals. The project was carried out by the Austrian Society for Metallurgy and Materials, ASMET, and its two project partners, the University of Leoben and the Austrian Institute of Technology (AIT former ARCS Seibersdorf). More than 100 experts from 80 institutions, mainly from industry, participated in preparing the technology roadmap. The breadth of contributors facilitated looking at and analysing trends and technology development from many viewpoints. The outcome is a representative picture of relevant trends and technological developments to be expected in the future in high performance metals.

Inter-institutional Technology Roadmap Approach for High Performance Metals

Austria, with its companies and research foci, puts an emphasis on materials and materials technology. Among the materials, high performance metals play a crucial role for the Austrian economy and its future development. In terms of technology policy, the questions to be answered by the development scenarios and the measures to be taken represent a generic challenge for a national technology strategy.

For Austrian businesses and research institutions, the very turbulent economic developments of the last years clearly show that focusing on technological and systematic development of these strengths can be seen as an essential contribution to economic survival. Operating in a field of tension between suppliers, competitors and customers, they must be well prepared for future technological scenarios.

We can assume today that new technologies have to be developed by 2020. For the study of high performance metals, a variety of development challenges will appear in advance of these future technological developments. In order to seize these industrial developments as an opportunity for innovation, materials development has to start significantly earlier in time. All new high-performance metals require an at least ten-year period for development before an innovation finds its way into practical applications. Even for incremental improvements of high performance metals, we must expect a development period of three to five years. It is therefore very important that industry and technology policy together work out development strategies beforehand.

To lay the groundwork for informed decision-making, a cross-technology roadmap for high performance metals processing has been developed, supported by BMVIT funding. The project was carried out by the Austrian Society for Metallurgy and Materials, ASMET and their project partners University of Leoben and ARCS Seibersdorf. More than 100 experts from 80 institutions were actively involved in creating the technology roadmap. The breadth of contributors made it possible to look at and analyse trends and technology developments from many different angles, giving a picture of the relevant developments in the future of high performance metals from the participants' perspective.

The Roadmapping Process: Expert Opinions and Scenario Workshops

Methodically, the roadmapping process consisted of two major phases. A first phase was concerned with determining whether action is needed for creating a national inter-institutional technology roadmap for high performance metals in general. The key issues to be addressed in the roadmap were also defined. During this exploratory phase, more than 30 Austrian experts and managers were interviewed. It clearly showed that there is massive demand for an inter-institutional roadmap.

In order to place the need for action identified in the exploratory phase in a comprehensive overall context, the second phase of the technology roadmap considered industry-oriented technological developments and developed actions and necessary measures for advancing high performance metals. The leading industries investigated ranged from power engineering to the mobility industry, with the sub-sectors aerospace, automotive and railway, and from the metallurgical sector to mechanical engineering. In addition to the sector specific perspective, technological trends in the crosscutting field of environment and resource management were addressed. In a detailed analysis beforehand, existing technology roadmaps in similar areas were examined, especially from English-speaking countries. The analysis determined what the lasting changes in the respective industry were and what had led to these changes.

Participation and Workshops

In a series of workshops, we identified the relevant developments and measures that have to be taken. The workshops were attended by representatives from industry and research in the field of high performance metals and representatives of companies downstream in the supply chains of a particular industry.

A total of eight workshops were conducted, involving between 10 and 20 participants each. Each workshop was structured such that relevant trends were verified in the beginning and discussed in a first phase. Subsequently, the changes expected in the market by 2020 were identified.

In order to highlight the relevant developments, the selected challenges were prioritized. In a next step, the developments expected in the field of high performance metals and their production and processing technologies were worked out. The workshops concluded by prioritizing these developments.

The last part of each workshop was devoted to developing individual measures suited to meet the challenges. Written reports of the individual workshops were compiled to inform the participants about the results.

Subsequently, the results of all the workshops were condensed into a single report. This condensed report was then sent to all participants in the roadmap process for further comments. At the same time, the report served to clarify whether or not further experts needed to be consulted to answer additional questions or further expert meetings were required to address identified knowledge gaps.

Aggressive Research Needed for Austria to Maintain Position

All industries showed the same crossover scenarios. The problem of future energy availability is turning into a major driver of development. Global scenarios predicting social and economic growth outside of Europe dominate the critical paths of development for the business location Austria in the field of high performance metals. An essential result of the roadmap is that we can expect growth only in sectors where aggressive research efforts are combined and focused on technology for innovative processes and products. However, this will only happen in favourable niches or at least in areas where it is possible to defend the current position in the field of high performance metals. Basically, the proposed measures recommended in the technology roadmap can only succeed if Austria remains committed to being a production site for high performance metals. Regardless of the sector considered, the technology roadmap shows that a positive image for high performance metals and related production technologies must be built in order to attract appropriate human resources, to train junior staff and to increase the pool of knowledge workers significantly.

Mobility

Progress in the whole area of mobility is linked most intensively and significantly with innovations in the field of high performance metals. The technology roadmap focused on the automotive industry, aviation and railways. All three sectors are generally expected to grow by 2020 although the current economic crisis will reduce the growth rate. The pressure to innovate by creating new products and processes is growing, driven by international competition based on established research resources.

Dominant development issues in the field of mobility are lightweight, energy conservation and new drive concepts. The need for lightweight construction leads towards a unique competition of materials by substitution in the field of high performance metals. Considering the high performance metals only, those will be favoured that have low densities or perform with extremely high

strength and stiffness properties. Life cycle assessment and the possibilities of recycling high performance metals after the use phase will gain much more importance than today in the selection of materials.

High performance metals, required to achieve new economic goals and technological solutions, are still in the basic research stage. Within the period considered in the technology roadmap, high performance metals have to be developed and optimised across all process steps in the value chains. Areas of development mentioned are metallurgy, metal forming, casting techniques, joining and surface technology. Solutions for technological problems will be increasingly coupled with a focus on cost-efficient production technologies. Today's technologies are often limited by an increasing lack of technological development potential. The development of new breakthrough technologies would be required to implement innovations in the field of high performance metals.

The measures proposed aim at reaching a stronger interdisciplinary integration of research and technical areas and pursuing important systemic research issues in supercritical and visible international research units based on a sustainable and topic-oriented research funding landscape.

Power Engineering

The energy industry is characterized by strong growth in demand combined with inadequate availability and uneven global distribution of energy resources. Development scenarios show both an investment boom in the area of high performance power plants as well in the area of more local, autonomous power supply units. Performance and efficiency gains in thermal power plants are only possible with an increase in operating temperatures, pressures and in the dimensions of the major components and assemblies. Today's materials solutions based on high performance metals do encounter limits in terms of fatigue, creep and corrosion resistance and can only be extended further by intensive materials science advancements. Innovation challenges are the development of customized materials solutions combined with a reliable and reproducible production technology. The increasing size of critical parts such as valves, turbine rotors or casings set technological limits to currently used technologies, such as casting or forming.

In the field of renewable energies, which will likely allow an autonomous energy supply, Austria’s development potential and thus the need for developing high performance metals was not rated very highly by the participating experts and companies. An issue that will gain even more importance in the future is energy transport and energy storage. The participants assessed them to be very user- and market-oriented already now.

Measures to promote high performance metals in the field of energy technology require a concentrated effort at developing knowledge about already known materials, including the development and optimisation of manufacturing technologies, such as casting, forming and joining technologies, and the structural design and testing of large components. This development must be aligned internationally and performed within major international networks to develop efficient and economically viable solutions. This also requires aligning research funding and grants accordingly. The subject of energy technology and high performance metals must in general be given more room and attention and must receive more sustainable funding in the Austrian research promotion and funding landscape because of its national strategic importance.

Metallurgical Engineering

The trends of development in metallurgical engineering again reflect the developmental needs and the developmental orientations of other industries. Thus, metallurgical mechanical engineering is faced with increasingly larger magnitudes of processed materials, growing demands on strength and difficulties in processing high performance metals. Due to the required heavy investment in development units, it is not expected that a breakthrough technology can be realized within the time frame of the roadmap. Improvements will rather have an incremental character; development potentials for high performance metals are identified where an increase in process efficiency and effectiveness can be realised or the lifetime of production facilities can be increased at higher levels of utilisation. Measures recommended are again intensified networking of metallurgy research with the metallurgical and downstream industries, as well as the increased use of modelling and simulation based on a sophisticated database. This will lead to better process control and knowledge-based further development of technological standards.

Environment and Resources

Environment and resource protection in the production of high performance metals is clearly a very important crosscutting issue, which no group of high performance metals can escape. The rising global demand for raw material resources raises questions concerning the availability and accessibility of raw materials by 2020. As demonstrated in the days before the economic crisis, volatile commodity prices are a serious problem, which cannot be solved by technological measures alone. From a technological perspective, the use of recycled materials in the production of high performance metals constitutes a major factor in relaxing this problem. The use of secondary metals to produce high performance steels has been successfully practiced for a long time already. However, in the field of high performance nonferrous metals, there is still a lot of potential but also a correspondingly great need for research both in materials as well as in technology development.

Strong Stakeholder Interest in a Common Strategy

The revised report was submitted to the BMVIT for authorization. After the BMVIT released the results of the technology roadmap, they were presented to the general public and especially to the key players in the field of high performance metals as well as to all members of the ASMET association.

The stakeholders showed strong interest in the results of the process and appreciated the formulation of a common strategy document, which can be considered an informal effect of the project in the sector. The policy recommendations developed in the roadmapping process have been partially implemented in the context of targeted measures and individual projects.

Furthermore, in 2011, a project consortium, consisting of ASMET, the University of Leoben and the Austrian Institute of Technology, proposed a follow-up foresight to succeed the roadmapping process. The aim of the suggested foresight is to highlight the societal context of future developments in the materials sector on a global scale to go beyond a narrowly technological perspective in the roadmapping process. In addition, the submitted foresight proposal aims at identifying relevant framework conditions in order to facilitate political decision-making, not only in the field of high performance metals but for the Austrian materials sector as a whole.

Reference

Jäger, H. (2009): Technology Roadmap High Performance Metals 2020. Final report, 1st issue. Leoben: ASMET– The Austrian Society for Metallurgy and Materials.

The EFP is financed by the European Commission DG Research. It is part of a series of initiatives intended to provide a 'Knowledge Sharing Platform' for policy makers in the European Union. More information on the EFP and on the Knowledge Sharing Platform is provided at www.foresight-platform.eu