

## Impacts of Advanced Materials on Economy and Society - Strategic Implications and Policies

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### ABSTRACT

*Advanced materials are part of new global technological revolution. They have both innovative and transformative potential. The main potential impact of advanced materials is the transformation of material base of economy. The impact of advanced materials has strategic character and their application is necessary for sustaining the competitiveness of economy as also its products on global and globalized markets. Development and use of advanced materials is now a strategic priority in developed countries as well as countries that are trying to be developed countries closer. Advanced materials will contribute significantly to economic growth, environmental protection and welfare of citizens.*

**KEY WORDS:** *advanced materials, technological revolution, competitiveness, transformation, strategy*

### Introduction

Advanced materials are part of new global technological revolution. They have both innovative and transformative potential. The main potential impact of advanced materials is the transformation of material base of economy. The impact of advanced materials has strategic character and their application is necessary for sustaining the competitiveness of economy as also its products on global and globalized markets.

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### Advanced Materials and Global Technology Revolution

According to Levan V. Basbanes „advanced materials can be defined in numerous ways; the broadest definition is to refer to all materials that represent advances over the traditional materials that have been used for hundreds or even thousands of years. From this perspective advanced materials refer to all new materials and modifications to existing materials to obtain superior performance in one or more characteristics that are critical for the application under consideration.“<sup>1</sup>

Development and application of advanced materials is interconnected with the coming of the converging technologies (nano-, bio-, cloning-, genetic-, etc.)<sup>2</sup>. These technologies tend to be also called as a transhuman technologies. Advanced materials are also part of the sixth Kondratiev wave (50-60 year economic cycles), which are part of the fundamental innovations that will drag economic and social development in this wave.

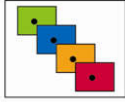
According to study Advanced Materials – Key Technology Area 2008-2001 advanced materials can include<sup>3</sup>:

- Lightweight materials and structures, including composites and hybrids,
- Materials to withstand more aggressive environments (e.g. high temperature, corrosive, erosive),
- Electronic and optical functional materials,
- Smart and multifunctional materials,
- Surface engineering, near-net shape manufacturing,
- Fibre and textile-based technologies,
- Bioresorbable, bioactive and biocompatible materials,
- Natural and bio-based materials,
- Joining technologies,
- Materials for portable power sources (batteries/fuel cells)
- Materials with reduced environmental impact through life,
- Materials designed for reuse/recycle/remanufacture,

<sup>1</sup>Basbanes, Levan V. (editor): AdvancedMaterialsResearchTrends. NovaSciencePublishers, 2007

<sup>2</sup>Roco, Mihail C., Bainbridge, WilliamSims (editors): Converging Technologies forImprovingHumanPerformance. Nanotechnology, Biotechnology, InformationTechnology and CognitiveScience. NSF/DOC Sponsored Report. KluwerAcademicPublishing, Dodrecht, TheNetherlands, 2003

<sup>3</sup>Advanced Materials. Key Technology Area 2008-2011. Technology Strategy Board, Swindon, 2008



- NDE/SHM/condition monitoring,
- Predictive modelling through the full life cycle, including lifetime prediction.

According to Advanced Materials Horizon Panel Report. Building a Future, One Layer at a Time “the contribution of materials and engineering to the shaping of society has remained consistent over time. Whereas in the past materials were relatively simply, today technological developments, relating to the composition and structure of materials at an atomic level, endow them with exactly the desired properties to allow them be manipulated as required. These materials, termed advanced materials, are as likely to define the future as simple materials have defined the past.”<sup>4</sup>

The same document stated that “all sectors globally are now dominated by a multitude of advanced materials. Advanced materials research and development has become multidisciplinary. It incorporates the convergence of key enabling technologies such as of chemistry, physics and biology, which coupled with advanced engineering capability improve the competitiveness of technology based enterprises and pave the way for prosperity and employment in modern industrial societies.”<sup>5</sup>

### **The Impacts of Advanced Materials on Economy and Society**

The advanced materials have broad impact on all levels of economy and society, as also on their structure. The change of material base of economy is interconnected with the impacts of all new technologies of second phase of the information age and the manipulation at very small level makes the current system of economy and society obsolete. The main impact of advanced materials will have deep impact on foreign trade, investment systems and schemes and necessary need of resources and raw materials. The advanced materials will be connected with the trends of localization, completing global structure with local substructures as also with ephemeralization of economy on all levels.

Benefits of advanced materials are following<sup>6</sup>:

- Design freedom
- Customisation / Personalisation
- Lightweighting
- Supply chain efficiency
- Small production runs
- Elimination of pre-production process
- Distributed / decentralized manufacture
- Complexity of shape and function
- New materials and structure
- Reduced need for storage / warehousing

Barriers to advanced materials are following<sup>7</sup>:

- Cost effectiveness
- Upscaling to production
- Reliability and quality
- Pre- and post-production
- Standardization
- Physical properties
- Materials
- Fragmented supply chains
- Intellectual property
- Computer-aided design

### **The Strategic Potential of Advanced Materials**

Advanced materials are an important strategic priority within all major knowledge economies. Not only are advanced materials considered to be critical drivers of innovation across a range of important technologies and industrial sectors, but they are also seen as essential for underpinning key areas of high value manufacturing, as well as addressing a range of important societal ‘grand challenges’ in areas such as mobility, healthcare and energy.

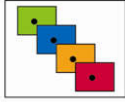
The main strategic potential of advanced materials is the increase of competitiveness on all levels with growing use of domestic resources and less dependency on foreign resources.

<sup>4</sup>Advanced Materials Horizon Panel Report. Building a Future, One Layer at a Time. MATRIX Report Vol. 5, 10/2008

<sup>5</sup>Ibid.

<sup>6</sup>Future Technology Landscape. Case Study Documentation. RAND Europe, 2013

<sup>7</sup>Ibid.



The long-term strategies on application advanced materials are prepared in all developed countries e.g.:

- USA – Materials Genome Initiative (2011)
- Great Britain – Eight Great Technologies (2013), (2014)
- European Union – Key Enabling Technologies (2011- )
- Japan
- Canada
- Israel
- Australia – Australian Advanced Materials
- New Zealand

And also in less developed countries e.g.:

- China – Programs 863 and 973
- Saudi Arabia – Strategic Priorities for Advanced Materials Technology Program (2008)

The advanced materials have potential impact on economic growth e.g. according to Advanced Materials Leadership Council “the development and manufacture of advanced materials is strategically important to the growth of the UK economy. UK businesses that produce and process materials have a turnover of around £170bn, represent 15% of the country's GDP and have exports valued at £50bn. The extreme diversity of advanced materials means that they have the potential to improve products or create new applications in a wide range of sectors; including those areas where the UK has industrial strategies”<sup>8</sup>.

According the same material “advanced materials were identified by the Government as one of the "eight great technologies" where the UK can be world leading due to the UK's long-established reputation for excellent materials science and related industrial strengths. Government wants to capitalise on the innovation potential within UK materials research and also build the skills that the UK will need for the future. This requires strong leadership across the innovation pipeline”<sup>9</sup>.

#### **European Policies and Strategies for Advanced Materials**

Advanced materials are viewed as one of the nine assistive technologies (Key Enabling Technologies KET), which can be road to growth and job creation in line with the European Strategy for Key Enabling Technologies (A European Strategy for Key Enabling Technologies - A Bridge the Growth and Jobs)<sup>10</sup> adopted by the European Commission in March 2012. This strategy is intended to ensure the competitiveness of European industry on a global scale.

For the purpose of support the creation the strategy for Key Enabling Technologies was set up the High Level Group in 2010 to advise on the elaboration of a Key Enabling Technologies strategy. To ensure the successful implementation of the EU strategy on Key Enabling Technologies, a second High-Level Group (HLG) was established in 2013.

The Status Implementation Report of the second Key Enabling Technologies (KETs) High-Level Group (HLG) proposed actions and recommendations to support the reindustrialization of Europe and boost European competitiveness.

Ten recommendations were presented under two key headings<sup>11</sup>:

- the reindustrialization of Europe through KETs innovation;
- KETs enablers to support European competitiveness and jobs.

KETs are a group of six technologies<sup>12</sup>:

- micro and nanoelectronics,
- nanotechnology,
- industrial biotechnology,
- advanced materials,
- photonics,
- advanced manufacturing technologies.

#### **Opportunities and Benefits of the Use of Advanced Materials in the Slovak Economy**

Slovak economy has great opportunity to make completely restructuralization of the industrial sector on the base of advanced materials via participation on projects of Key Enabling Technologies with possibility of participation on financial sources of the projects as also of possibility of financing from European Investment Bank.

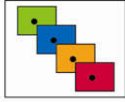
<sup>8</sup>Advanced Materials Leadership Council. 2015, <https://connect.innovateuk.org/web/amlc/home>

<sup>9</sup>Ibid.

<sup>10</sup>Key Enabling Technologies – A bridge to growth and jobs. MEMO, European Commission, Brussels, 26 June 2012

<sup>11</sup>Ibid.

<sup>12</sup>High-Level Expert Group on Key Enabling Technologies. Final Report KETs: TIME TO ACT. European Commission. June 2015



After fall of communism in Slovakia it is first opportunity to renew Slovak industry on new resource and technology level, which can be compatible with all developed countries of European Union. The potential of advanced materials in Slovak industry is the creation of new jobs, the growing competitiveness and growing resource and material independence on all levels of Slovak economy.

### **Measures and Policies for Advanced Materials**

The key areas for application of advanced materials with deep and specific impact are following:

- Energy
- Sustainability
- High Value markets

Slovakia has to formulate long-term strategy on potential use of advanced materials in Slovak economy including:

- Adaptation and application of policies and strategies of the European project Key Enabling Technologies
- Adaptation and application of selected policies and strategies for advanced materials from countries as USA, United Kingdom, Germany, Japan, China etc.
- Formulation a long term policies and strategies for adaptation of advanced materials in Slovak industry with focus on domestic resources and growing independency on foreign resources
- Application of advanced materials policies on all energy sector in Slovakia
- Formulation of key policies for advanced materials to support sustainability and sustainable development
- Support of new high value markets of advanced materials

The realization of policies and strategies supporting advanced materials can lead to increasing the energy efficiency of the Slovak economy, promote the development of science and research in this area with potential positive impact on the Slovak economy and increase of national security with possible impacts on the Slovak economy.

The realization of such policies and strategies measures will have a positive impact on Slovakia's economic growth and job creation as well as to improve the living standards of the population. Proposed measures and policies can be the part of the economic policy and long-term strategy of development of the Slovak economy.

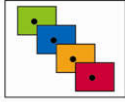
The proposed measures to promote the use of advanced materials in the Slovak economy has to take into account the recommendations of the Expert Group European Commission Key Enabling Technologies, contained in the report of the Group, aimed at securing Europe's industrial and innovation capacity. The use of advanced materials has to be included among the strategic priorities of economic policy.

### **Conclusion**

Advanced materials are great opportunity for Slovakia for support of competitiveness growth of the Slovak economy, growth of jobs, making Slovak economy less dependent on foreign resources and to make the Slovak economy part of stating global technology revolution with using it to increase of wellbeing of Slovak citizens. Advanced materials are critical for the next decade for transition of Slovak industry towards greater value-added and for creating new resource base compatible with European Union.

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