European Commission

Potential areas of industrial interest relevant for cross-cutting KETs in the Chemical Processes, Chemicals, Chemical Products and Materials domain

This fiche is part of the wider roadmap for cross-cutting KETs activities

'Cross-cutting KETs' activities bring together and integrate different KETs and reflect the interdisciplinary nature of technological development. They have the potential to lead to unforeseen advances and new markets, and are important contributors to new technological components or products.

The complete roadmap for cross-cutting KETs activities can be downloaded from:

http://ec.europa.eu/growth/industry/key-enabling-technologies/eu-actions/ro-ckets

This innovation field is part of the wider roadmap for cross-cutting KETs activities developed within the framework of the RO-cKETs study. The roadmap for cross-cutting KETs activities identifies the potential innovation fields of industrial interest relevant for cross-cutting KETs in a broad range of industrial sectors relevant for the European economy.

The roadmap has been developed starting from actual market needs and industrial challenges in a broad range of industrial sectors relevant for the European economy. The roadmapping activity has focused on exploring potential innovation areas in terms of products, processes or services with respect to which the cross-fertilization between KETs can provide an added value, taking into account the main market drivers for each of those innovation areas as well as the societal and economic context in which they locate.

Taking the demand side as a starting point, cross-cutting KETs activities will in general include activities closer to market and applications. The study focused on identifying potential innovation areas of industrial interest implying Technology Readiness Levels of between 4 and 8.

CH.1.2: Metamaterials or novel chemistries for the substitution of rare elements and other critical raw materials

Scope:

Metamaterials or novel chemistries to be applied as safe and cost-effective equivalents to rare and toxic adjuvants to various productions, or minimal use of them, with application e.g. in catalysts without precious metals (especially without Platinum), permanent magnets and battery electrodes without rare earths, replacement of Indium Tin Oxide (ITO) where thin transparent oxides are needed as in screens and displays, etc.

Demand-side requirements (stemming from Societal Challenges) addressed:

Tackle the “climate action, resource efficiency and raw materials” challenge, indirectly also contributing to address challenges such as “smart, green and integrated transport” and “secure, clean and efficient energy”

Demand-side requirements (stemming from market needs) addressed:

- Provide for the substitution of rare elements and other critical raw materials, thereby addressing security of supply for key market sectors

Specific technical / industrial challenges (mainly resulting from gaps in technological capacities):

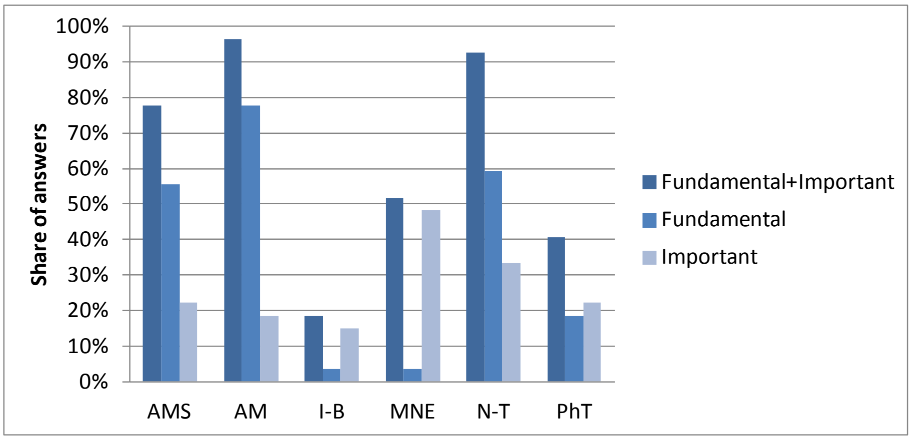
- Development of innovative material structures and chemistries
- Replacement of Cadmium (used for example in obtaining the red colour in glass) or Boron (used for example within the boro-silicate glass used in pharmaceutical containers), with performing non-toxic and low cost equivalents
- Characterization of toxicity as well as risks for purchase difficulties of all key adjuvants (Mercury, Arsenic, Boron, etc.)
- Development of synthetic materials with equivalent properties to replace toxic or rare materials for application e.g. in catalysts without precious metals (especially without Platinum), permanent magnets and battery electrodes without rare earths, for the replacement of Indium tin oxide (ITO) where thin transparent oxides are needed as in screens and displays, etc.
- Development of alternative solutions allowing to use necessary adjuvants just where needed, including only as a surface coating if not needed inside the material (e.g. anti-bacterial adjuvants)

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of innovative material structures and chemistries allowing to replace rare or toxic substances with performing non-toxic and low cost equivalents, thanks to the development of synthetic materials with equivalent properties. The integration of KETs could moreover contribute to developing alternative solutions allowing to use necessary adjuvants just where needed, including only as a surface coating if not needed inside the material (e.g. anti-bacterial adjuvants).

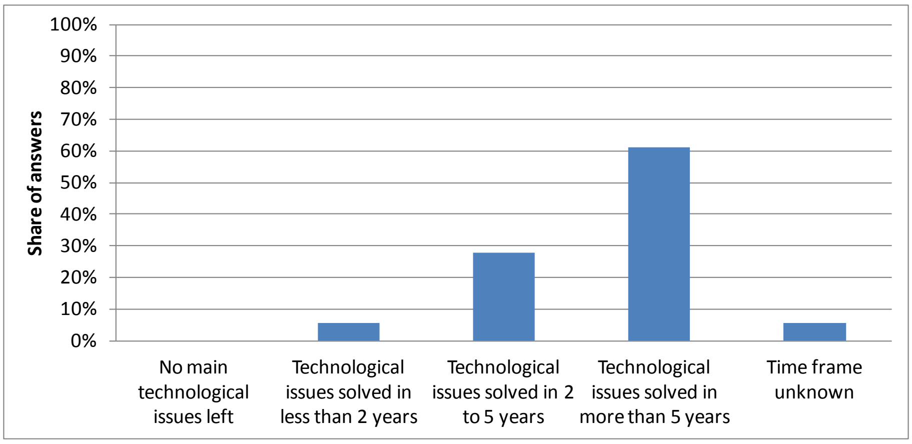
To this aim, the combination of KETs experts’ opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong interaction of KETs with respect to this Innovation Field, with either fundamental or important contribution mainly by the following KETs:

- Advanced Materials (AM)
- Nanotechnologies (N-T)
- Advanced Manufacturing Systems (AMS)



Timing for implementation:

According to the majority of KETs experts' opinions (whose result is depicted in the below bar chart), desk research, and in line with the KETs-related patenting activity in this field, it is considered that the main technological issues holding back the achievement of cross-cutting KETs based products related to this Innovation Field could be solved in a time frame of more than 5 years:



Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the medium term should be taken into consideration within this framework.

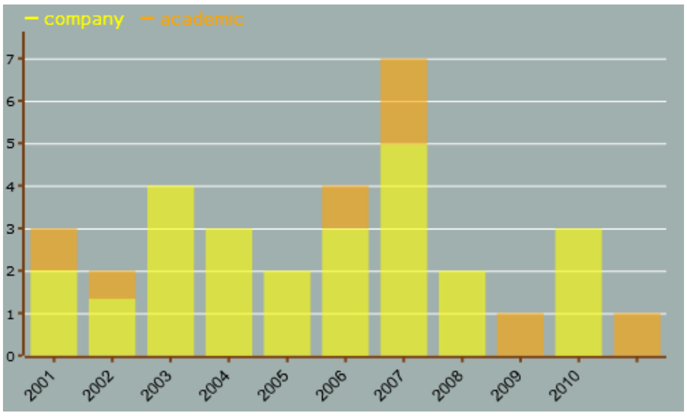
Additional information according to results of assessment:

- ***Impact assessment:***
  - Rare earth elements and other critical raw materials are essential to industrial production and thus to many key market sectors. They are involved in wind turbines, solar cells, electric vehicles, energy efficient lighting, many other electric and electronic devices, catalysts for chemical production, just to name a few. Wind turbines are among the most rapidly growing sources of electricity generation in Europe and elsewhere. Solar photovoltaic cells are steadily declining in cost, which will result in their even more widespread application within the coming decade. Electric vehicles, meanwhile, offer a means to move away from imported oil for transport towards a more sustainable energy mix and their adoption is also expected to grow significantly. Compact fluorescent and Light-Emitting Diode (LED) lighting allow to greatly reduce electricity consumption. Modern electric and electronic devices and technologies pervade most aspects of society. Catalysts are widely applied in the chemical industry for the production of a large variety of intermediates as well as end products. These and other options can contain smaller (but vital) to larger amounts of critical raw materials, thus leading to high quantities of materials being used in a highly distributed form; quantities which are expected to grow along with their respective end markets.

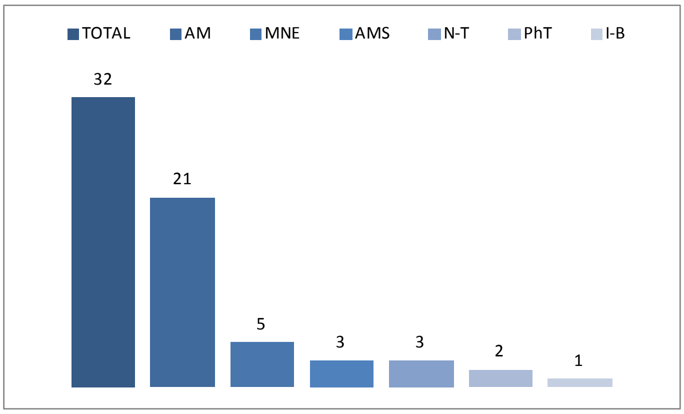
- Production of some of these rare earth elements and other critical raw materials is concentrated in very small world portions (production of many of these materials is predominantly from outside Europe; in many cases it is dominated by a single country or region and thus affected by conflicts over access as well as geopolitical and trade issues), which lets assume that supplies might become tight and costs prohibitive as markets grow. If this would occur, there would be serious impacts in key market sectors as a consequence of the restricted supply of these materials.
- Metamaterials have been widely studied for applications in the aerospace and defence sector, particularly referring to innovative antenna systems. Such developing knowledge can find its alternative applications in civil markets, strengthening its possibility to be commercialised in the medium-term.
- Sources: European Commission, Critical raw materials for the EU, Report of the Ad-hoc Working Group on defining critical raw materials, June 2010; Materials Security Special Interest Group of Technology Strategy Board Network, Innovation Opportunities and Material Security, 2012

➢ ***Results of patents scenario analysis:***

- 32 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
- Unstable trend curve (number of patents per year) with a generally low patenting activity per year
- Highest share of industrial applicants with intermittent relevant patenting activity by academic applicants, most probably standing for new technologies having been patented in the corresponding periods:



- Patents by KET(s):

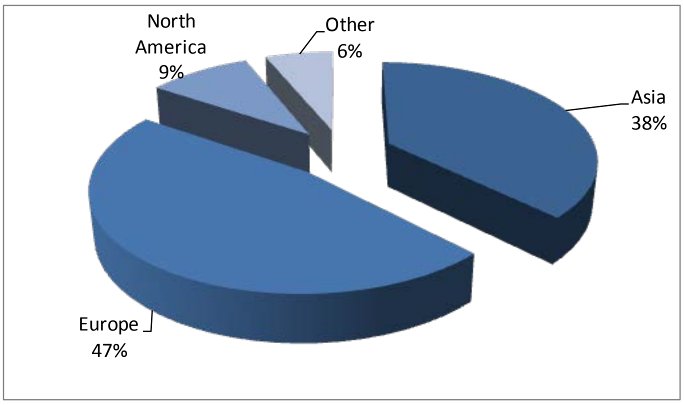


- Patents by KET(s) and relevant combinations of KETs:

KET(s)	*Number of patents*
AM	21
AM / N-T	1
AM / PhT	1
AMS	3
IBT	1

KET(s)	Number of patents
MNE	5
MNE / PhT	1
N-T	3
PhT	2

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: