European Commission

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

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

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.2.2: Advanced materials and new material architectures with added functionalities

Scope:

To develop advanced, mainly structural, materials with added functionalities, such as for sensing or self-repair, and new material architectures incorporating novel fibres, nanomaterials, etc., capable to provide added functionalities especially to large structures.

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

- Indirectly tackle challenges such as “climate action, resource efficiency and raw materials”, “smart, green and integrated transport” and “secure, clean and efficient energy” thanks to contributing higher performing materials for various applications that are key to the achievement of the aforementioned challenges

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

- Production of high performing materials with improved functionalities

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

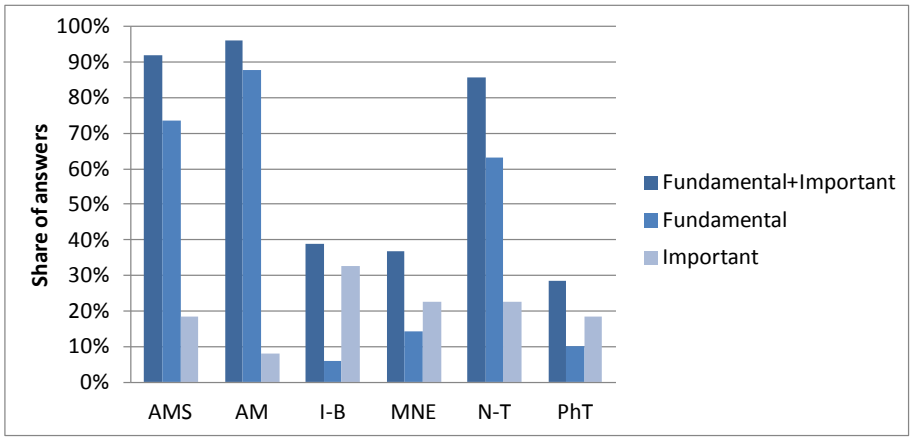
- Development of bio-inspired approaches to effect self-healing, which can be described as mechanical, thermal or chemically induced damage that is autonomously repaired by materials already contained within the structure
- Manufacture and incorporation of micrometric hollow fibres or capsules capable to release a repair agent (e.g. a resin) within both composite laminates and sandwich structures
- Incorporation of e.g. magnetic materials or structures within composite components to provide e.g. magnetic sensing functions
- Development and incorporation of stiffer and more rigid fibres into matrix materials (such as metals or plastics) to make a stiff but lightweight composite material with anisotropic properties

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of more advanced materials and new material architectures with added functionalities, thanks to e.g. the development of bio-inspired approaches to effect self-healing, the manufacture and incorporation of micrometric hollow fibres or capsules capable to release a repair agent within both composite laminates and sandwich structures, the incorporation of materials or structures, within composite components, to provide sensing functions, or other approaches capable to add ad-hoc functionalities to materials.

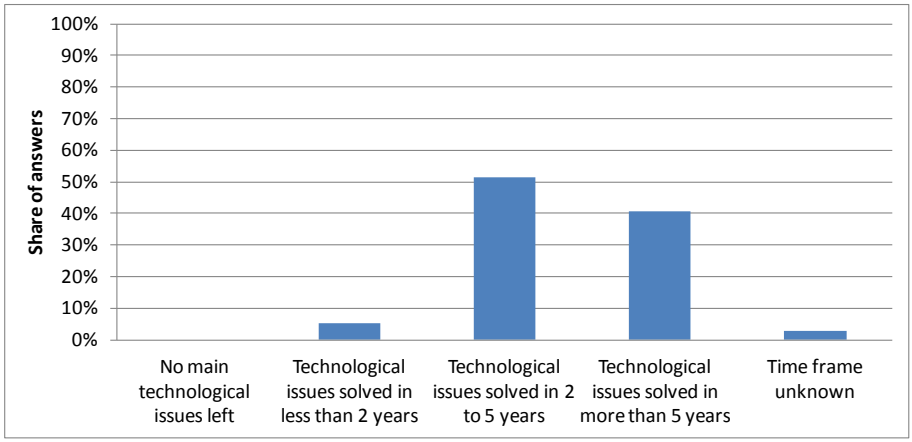
To this aim, the combination of KETs experts’ opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong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

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



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 2 to 5 years, yet significant consensus by experts indicates also greater periods being necessary:



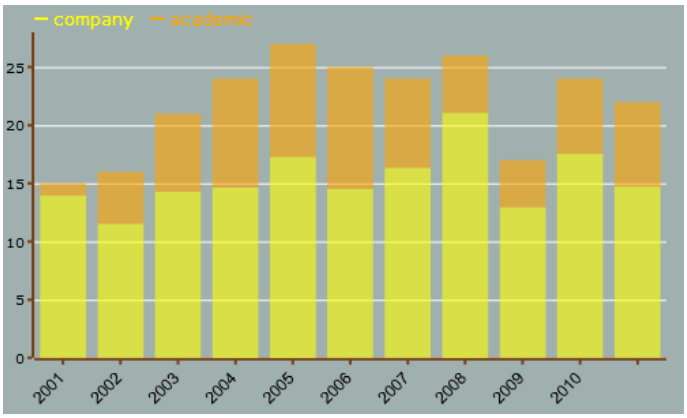
Depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, according to the authors' view, the provision of support in the short to medium term should be taken into consideration within this framework.

Additional information according to results of assessment:

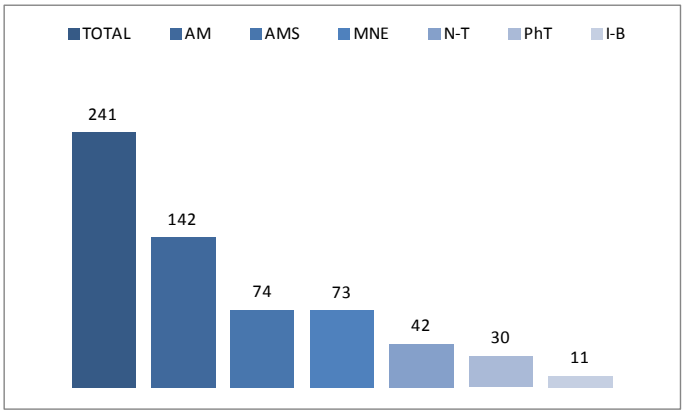
- ***Impact assessment:***
  - Advanced structural materials or new material architectures with added functionalities may include materials such as metals and alloys (ferrous and non-ferrous), ceramics, polymers, semiconductors, and composites, which are engineered thanks to knowledge-intensive processing methods or the incorporation of e.g. novel fibres, nanomaterials, etc., in order to achieve added functionalities and 'unique' material properties.
  - Differently from more conventional materials as well as conventional composite materials, these materials find their application in niche markets in which the added functionality represents a competitive advantage over conventional materials.
  - Added functionalities can provide, for example, for sensing or self-repair and can be achieved thanks to new material architectures incorporating novel fibres, nanomaterials, etc.
  - These materials are generally engineered in such a way to optimally respond to customers' requirements meaning that they are tailored to customers' specifications.
  - Also defence applications and equipment often make use of lighter and stronger materials, for example, on military aircraft, rockets, ground vehicles and munitions. Advanced materials are also used to

improve the performance of reduced radar visibility, coatings for jet engine performance, and armour for military vehicles. For some of these applications, especially regarding aircraft structures, there are strong ties with civilian developments and applications. Therefore this area is particularly linked to dual use applications.

- ***Results of patents scenario analysis:***
  - 241 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Almost stable trend curve (number of patents per year)
  - High participation of academic applicants in the patenting activity standing for technologies being still in the evolving phase:



  - Patents by KET(s):

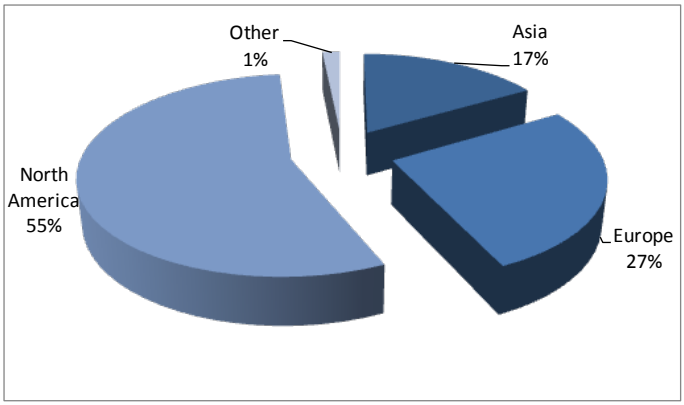


  - Patents by KET(s) and relevant combinations of KETs:

KET(s)	*Number of patents*
AM	142
AM / IBT	6
AM / IBT / MNE	3
AM / IBT / MNE / N-T	1
AM / IBT / N-T	2
AM / MNE	36
AM / MNE / N-T	11
AM / MNE / N-T / PhT	1
AM / MNE / PhT	7
AM / N-T	29
AM / N-T / PhT	2
AM / PhT	11

KET(s)	*Number of patents*
AMS	74
AMS / AM	15
AMS / AM / MNE	6
AMS / AM / MNE / N-T	1
AMS / AM / N-T	2
AMS / AM / PhT	1
AMS / IBT	1
AMS / MNE	17
AMS / MNE / N-T	3
AMS / MNE / PhT	2
AMS / N-T	5
AMS / PhT	9
IBT	11
IBT / MNE	3
IBT / MNE / N-T	1
IBT / N-T	3
MNE	73
MNE / N-T	18
MNE / N-T / PhT	1
MNE / PhT	13
N-T	42
N-T / PhT	3
PhT	30

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: