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 Manufacturing and Automation 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.

MA.1.9: Tools and equipment for manufacturing of high performance flexible structures

Scope:

To develop methods and technologies realising the full potential of high performance polymers and advanced textiles, including for 3D structured, multi-layered and hybrid materials, joint-free complex shapes, automated joining and a wide range of surface engineering and functionalization techniques.

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

Depending from the application or the type of processes used for production, manufacturing and automation can especially contribute to tackle the following societal challenges:

- Secure, clean and efficient energy
- Climate action, resource efficiency and raw materials

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

- Provide for rapid and flexible production capabilities to match supply with volatile demand of today's rapidly changing markets
- Flexibly integrate design specifications into efficient operational routines by keeping a comparable throughput time in different configurations
- Provide for fast product/service systems able to combine rapid and flexible production capabilities with enhanced product design capabilities and exploit minimal distribution lead-times to match supply with volatile demand of today's rapidly changing markets
- Provide for the production of high-quality products
- Provide for the production of durable products
- Provide for alternative manufacturing approaches coping with the need of utilizing new and advanced materials in products, adding functionalities to products, dealing with complex structures and shapes

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

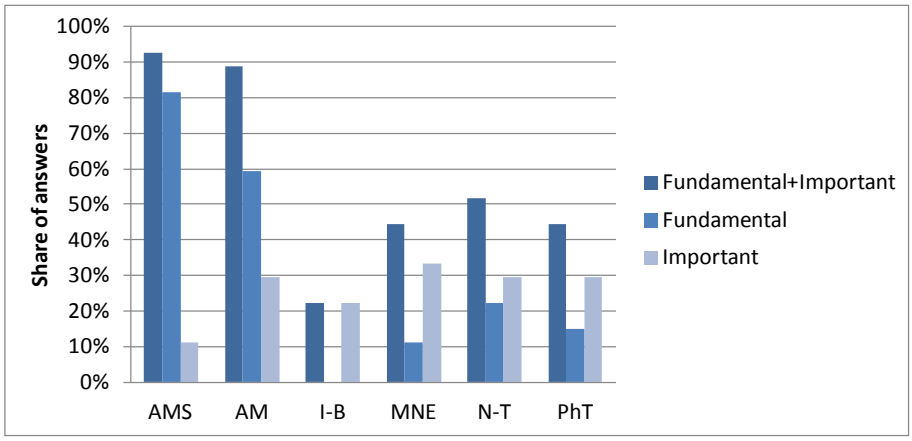
- Flexible Sheet-to-Sheet (S2S) and Roll-to-Roll (R2R), building in plastics electronics
- Increase use of polymers and advanced textiles (they are a large component of European manufacturing advantage)
- Combined benefits from processes, such as plasma, which can enhance functionality whilst also reducing energy consumption should be exploited. Other flexible structures are also relevant where they offer significant potential for European industry, examples include food products

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of methods, technologies, tools and equipment for the manufacture of flexible structures, capable of realizing the full potential of high performance polymers and advanced textiles, including for 3D structured, multi-layered materials and joint-free complex shapes, thanks to flexible Sheet-to-Sheet (S2S) and Roll-to-Roll (R2R) techniques along with surface engineering and functionalization techniques.

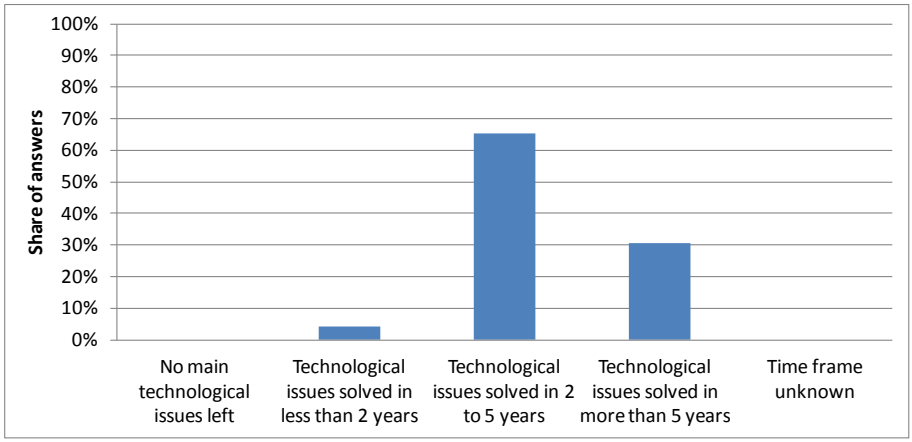
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong 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)
- Micro- and Nano-Electronics (MNE)
- Nanotechnologies (N-T)
- Photonics (PhT)



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 consensus by experts indicates also greater periods being necessary:



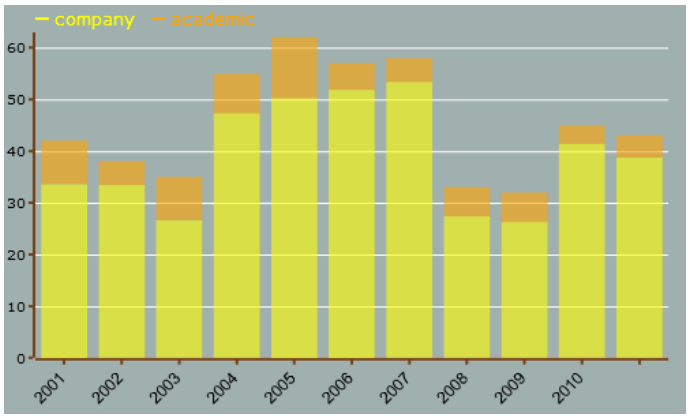
Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the short term should be taken into consideration within this framework.

Additional information according to results of assessment:

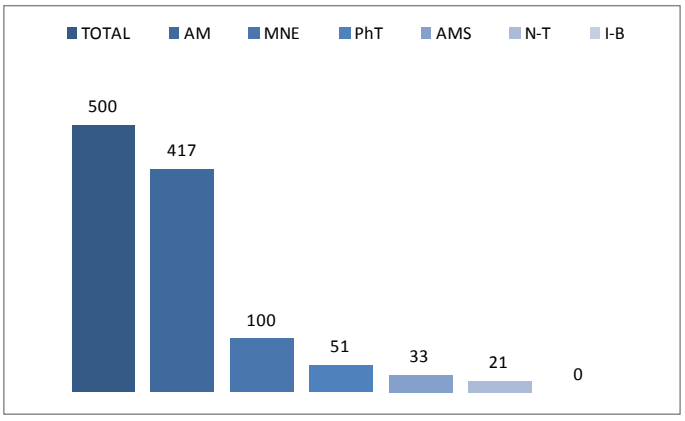
- ***Impact assessment:***
  - Used in diverse fields such as printed electronics and flexible PVs, flexible devices represent a category of devices that in recent years have experienced strong market growth due to their advanced characteristics. Flexible devices that are lightweight and can bend and conform to curved surfaces due to their thin profile provide versatility and allow for the creation of new and low-cost applications. As flexible devices become more popular, the need increases as well to use high-volume processes for their fabrication. Consequently, the industry is steadily transitioning to the integration of roll-to-roll (R2R) and sheet-to-sheet (S2S) technologies for fabricating these devices. Actually, the global market for flexible devices manufactured by roll-to-roll (R2R) and sheet-to-sheet (S2S) technologies was valued at nearly 8 billion Euro in 2012 and is projected to increase to nearly 16 billion Euro in 2017 after increasing at a compound annual growth rate (CAGR) of 16.1% (Source: BCC Research, Global Markets for Roll-to-Roll Technologies for Flexible Devices, 2013).
  - For a number of applications the available materials and manufacturing processes are already commercially successful. Technologically more demanding products, such as large area printed OLEDs and OPV cells on flexible substrates, however, require more sophisticated approaches and have not yet

been developed towards full readiness for market introduction. A major challenge in this respect is the transfer of the production from the research laboratory, where technology demonstrators are usually produced in small numbers by sheet-to-sheet (S2S) techniques, to a scale relevant to the industry, preferably on a roll-to-roll (R2R) basis (Source: E. Rubingh, Stepwise Process Optimisation for Printed Electronics Manufacturing from Small Scale Sheet-to-Sheet to Pre-Industrial Roll-to-Roll Production, 2014).

- ***Results of patents scenario analysis:***
  - 500 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Oscillating trend curve (number of patents per year)
  - Highest share of industrial applicants:



  - Patents by KET(s):

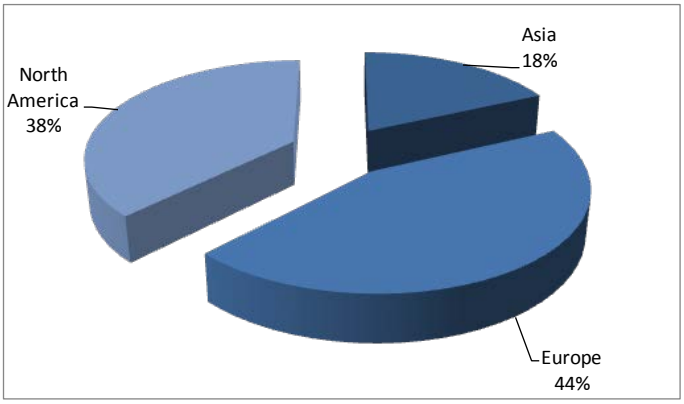


  - Patents by KET(s) and relevant combinations of KETs:

KET(s)	*Number of patents*
AM	417
AM / MNE	42
AM / MNE / N-T	2
AM / MNE / PhT	11
AM / N-T	11
AM / N-T / PhT	1
AM / PhT	29
AMS	33
AMS / AM	6
MNE	84
MNE / N-T	9

KET(s)	*Number of patents*
MNE / PhT	22
N-T	21
N-T / PhT	1
PhT	51

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: