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 Electronics and Communication Systems 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.

E&C.2.6: Flexible large-area electronics

Scope:

To develop semi-conductive inks, substrate treatments and related manufacturing processes enabling printed and thin film electronics, eventually organic, for lesser performance but lower costs of circuits (compared to silicon electronics), and for developing large scale and flexible integration of smart capabilities into textiles/wearable products, packaging, buildings, lighting, etc.

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

- "Innovative and reflective societies" and a competitive European economy need breakthrough innovations, smart capabilities or high performance, a large part of which will be made possible by improved or even radically new electronics components and circuits
- Energy and material resources efficiency are demanding much from electronic components, be it direct energy consumption reduction, advanced power management, low use of critical materials, recyclability, miniaturization, etc.
- Large areas monitoring – as for agriculture, forestry, marine resources, water resources, pollution monitoring, homeland security, etc. – require "smartification" of the environment, e.g. with high autonomy ubiquitous low cost sensing and communication capabilities, serviced by new components, circuits and architectures
- High value systems for energy, transport, health care as well as some industrial, space or military applications need components and circuits for highly demanding applications, severe vibration or temperature environments, high computing power, specific reliabilities, real time operations, miniaturization, upgrade/retrofit,etc.
- Electronic components being a basic bricks for all high added-value systems, maintaining an electronics industry in Europe is a critical matter of strategic non-dependence

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

- Electronics industry is a highly competitive market integrated into global value chains, with short cycles and requiring large investments. Keeping caught-up with Moore's law (computing power doubles every two years) as well as with new trends (non-computing capabilities grouped under the "More-than-Moore" concept) is a survival issue for the European electronics industry facing huge global competition
- With electronic and telecommunication systems getting more and more complex, developing circuits and components dedicated to a specific application is a key for competitiveness of entire industries. Industrial eco-systems in consumer or professional electronics require strong interactions with the components and circuits link
- Setting up the "Internet of Things", "Cloud computing" or "Big data" services are major requirements from many industries and services in Europe. It requires developments in components as well as from upper technical layers
- Cost is a key and all components design and production has to integrate competitive production aspects from the earliest phase

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

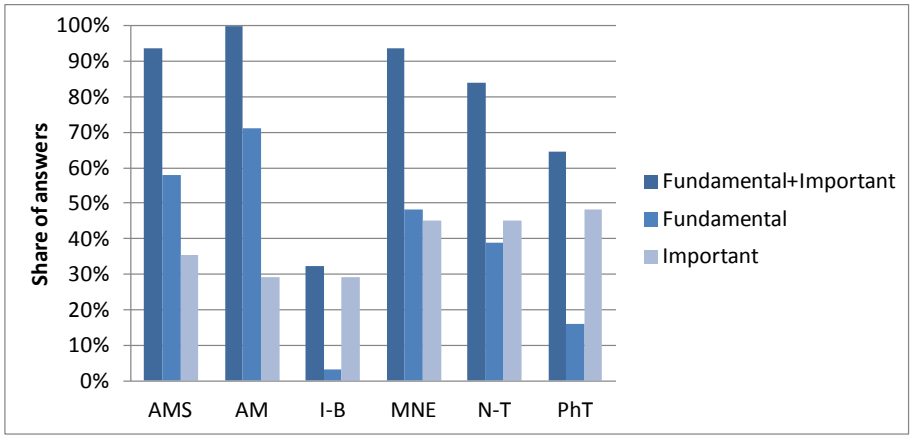
- Improvement of printed electronics for ubiquitous and flexible electronics (packaging, disposable electronic patches, "wearable electronics" incorporated on textile or cosmetics, chip cards, biometry, etc.), in particular for supporting smartification of all sorts of objects in the Internet of Things
- Improvement of conductive inks formulation and substrate treatment to reduce cost and adapt properties to final product requirements, in particular in terms of resistance to temperature or humidity
- Take advantage of organic electronics potential to develop low cost low computing power components, potentially including multiple functionalities on same circuits (luminescence, transparency, energy storage or generation, embedded memory, sensing, traceability, etc.)
- Development of high flexibility production processes (roll to roll, serigraphy, ink jet, etc.) for highly cost efficient large area printed electronics
- Development of small scale high energy density storage systems, as micro-batteries or small fuel cells, that are suitable for mobility-portability and/or autonomous applications

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the improvement of printed electronics for highly cost efficient large-area electronics applications thanks to the improvement of conductive inks formulation and substrate treatments. Requirements focus on resistance to temperature and humidity, multiple functionalities (e.g. luminescence, energy storage or generation, embedded memory, sensing, traceability, etc.), along with high flexibility and capacity production processes.

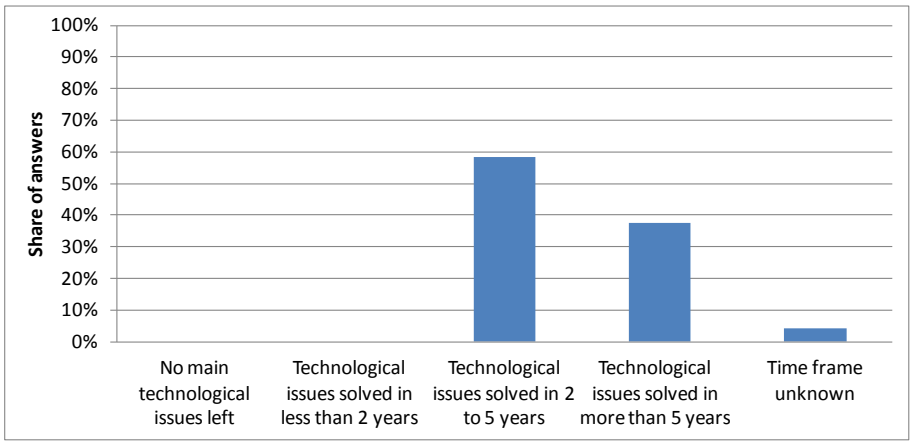
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong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

- Advanced Materials (AM)
- Advanced Manufacturing Systems (AMS)
- Micro- and Nano-Electronics (MNE)
- Nanotechnologies (N-T)
- A less fundamental input from 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 significant consensus by experts indicates also longer periods being necessary:

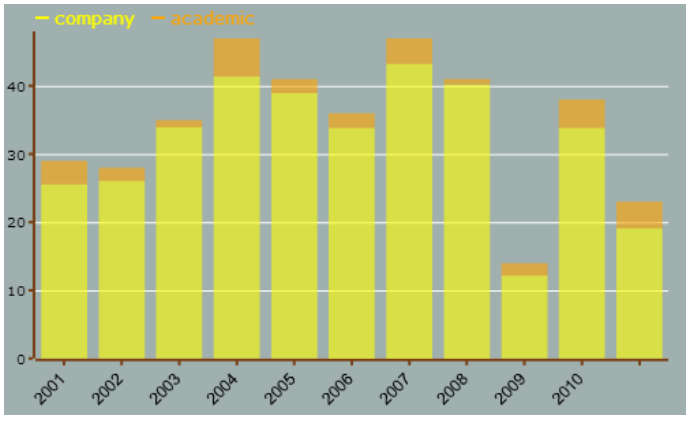


Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the short to medium term should be taken into consideration within this framework.

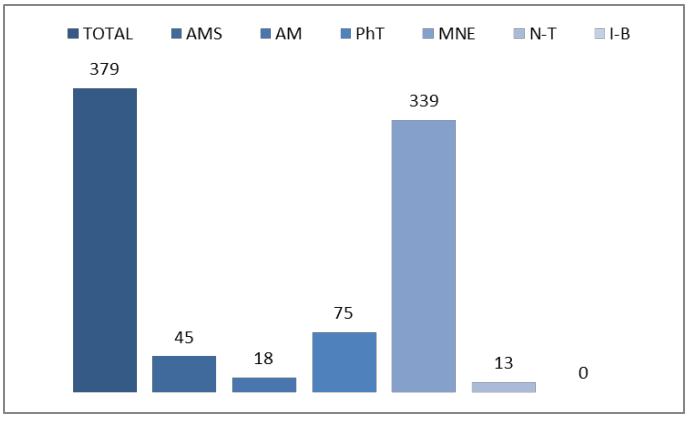
Additional information according to results of assessment:

- ***Impact assessment:***
  - Printed electronics allows producing low performance but low cost solutions for implementing smart capabilities into traditionally passive materials, such as building surfaces (wall papers, windows, etc.), papers or textiles. As such, it is a direct contributor to the "Smartification" of our everyday environment, to the "Internet of Things", "Smart Cities" and all forms of information enrichment of our environment.
  - A major application concerns energy efficient buildings, with opportunities on thin film photovoltaic, lighting, ambient conditions or materials aging monitoring. Others are in "intelligent" products packaging, i.e. in the agro-food sector, heating textiles, e-newspapers, advertisement, etc. All these are still emerging or even still-to-be-born markets but the lights and screens from printed organic Light-Emittign Diodes (LED) are in particular expected to grow from a few tens of million dollars in 2012 to several billion from 2015.
  - An important impact of the printed electronics sector is the opportunity to offer growth relays to the paper and printing industries, in difficulties in Europe in the recent years but still employing 850 000 persons in Europe and generating more 100 billion Euro annual turnover (source: EC DG Enterprise and Industry website).
  - Many opportunities for suppliers of the mentioned technologies can derive from the transfer of the technologies and know-how from the military and defence sector into civilian applications.

- ***Results of patents scenario analysis:***
  - 379 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Quite stable trend curve (number of patents per year) with a strong downturn in 2009, since in recovery
  - Highest share of industrial applicants:



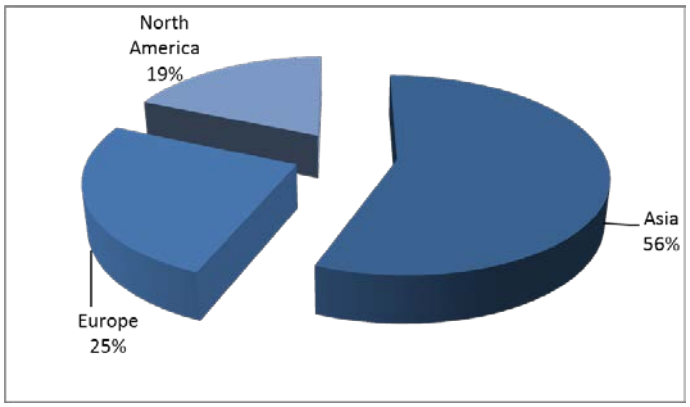
  - Patents by KET(s):



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

KET(s)	*Number of patents*
AM	18
AM / MNE	11
AM / MNE / N-T	7
AM / MNE / N-T / PhT	1
AM / MNE / PhT	2
AM / N-T	8
AM / N-T / PhT	1
AM / PhT	3
AMS	45
AMS / AM	1
AMS / MNE	16
AMS / MNE / PhT	5
AMS / PhT	7
MNE	339
MNE / N-T	10
MNE / N-T / PhT	2
MNE / PhT	69
N-T	13
N-T / PhT	2
PhT	75

- Patent distribution by (Applicant) organization geographical zone:
- Asian players, mainly Japanese, are dominant. However European players like Philips, Siemens, Infineon, Polyic, Alcatel, Epcos, CEA or NXP are still in the race



- Patent distribution by geographical zone of priority protection: