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 Transport and Mobility 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.

T.1.4: Advanced vehicle structures

Scope:

To develop vehicle structures – such as car chassis, aircraft airframes, ship hulls, train or satellite platforms, rocket fuselages, etc. - that are light-weight, crashworthy and wear/fatigue resistant (e.g. single-piece or rivet-less complex shapes), eventually functionalized, coated or otherwise treated for improved properties, and produced with minimal use of materials and chemicals, recyclable and cost-effective.

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

- Tackle the "Smart, green and integrated transport" societal challenge
- Contribute to the achievement of the EU Transport 2050 strategy (COM/2011/0144 final) objective of a 60% reduction of CO_2 emissions from transports, at least 40% for shipping
- Support the Smart Vehicle initiative of the i2010 strategic framework on the innovation society (COM(2005) 229 final)
- Continuously enhance safety, resistance/resilience and security of vehicle operation all along end-to-end transport chains
- Increase recyclability of vehicles and systems and resource efficiency in the manufacturing processes and reduce dependency to rare or foreign controlled materials and components (as per the Raw Materials Initiative (COM(2008)699) and numerous waste management regulations)

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

- Reduce vehicle operation costs, including through increasing energy efficiency and reducing final vehicle energy bill, but also through optimising overall vehicle lifecycle cost of ownership, including maintenance, repair and overhaul
- Reduce or maintain numbers and rates of accidents in Europe at an acceptable number, whatever traffic growth
- Enable new transportation services dealing with changing mobility and transportation needs, changing trade patterns as well as citizen and logistic chains request for affordable, timely, comfortable, seamless and ubiquitous transport services
- Enable time to market reduction and production ramp up / adaptation so as to cope with European and global market requests on new vehicle supply

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

- Development of low density resistant, reinforced, resilient (against fatigue, corrosion, incidents, attacks, etc.), shock absorbent and/or even self-healing / self-repairing materials (as fibre reinforced composites, ceramic/metal composites, advanced metallic alloys, etc.), including to allow operations in most severe conditions
- Understanding and modelling of structural fatigue of materials depending on operational constraints as vibrations, temperature, radiation levels, etc.
- Use of low energy and material consumption manufacturing processes, including re-use of manufacturing process energy (e.g. through heat exchangers), additive manufacturing, re-use of machine chips
- Develop one-piece / net-to-shape / molecular connection / advanced wielding manufacturing techniques for complex shapes (to limit joints, scraps and machining)
- Pre-shaping of high-value raw materials to reduce manufacturing operations, costs and waste and reduce supply constraints on structural designs
- Fill in of structural parts with functional properties (electrical or thermal conductivity, vibration dampening, radiation shielding, stealth, lightning protection, anti-icing, aesthetics, friction or shock resilience, emissivity, etc.), possibly with functional coatings
- Increased production ramp up capability (through out-of-autoclave and other manufacturing means)
- Enabling of high quality low cost mass production and ramp up, possibly including with mass-customization capabilities
- Consideration of lifecycle from design, including fatigue, wear, maintenance, repair and end of life

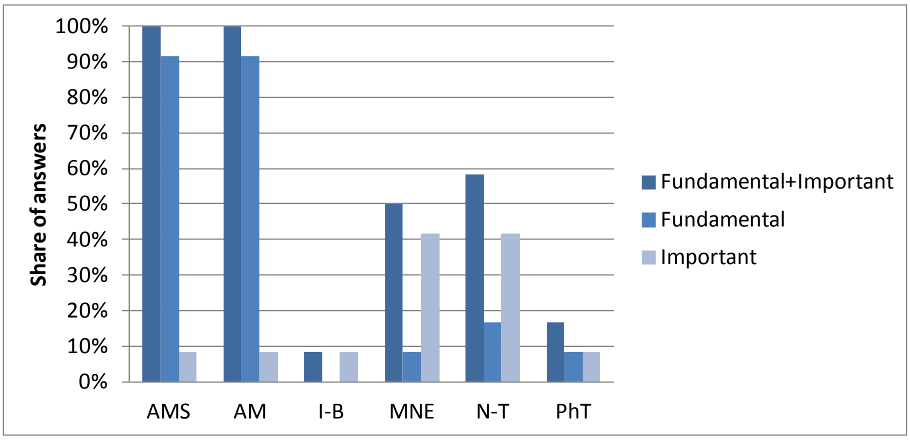
- Ensuring of compliance of materials used with REACH, RoHS and any other regulation on toxic, environmentally damaging, rare or critical for any other reason materials

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of advanced vehicle structures building on multifunctional, resilient and self-healing/self-repairing materials and coatings to allow operations in most severe conditions, along with low energy/resource consumption manufacturing processes to reduce manufacturing operations, costs and waste.

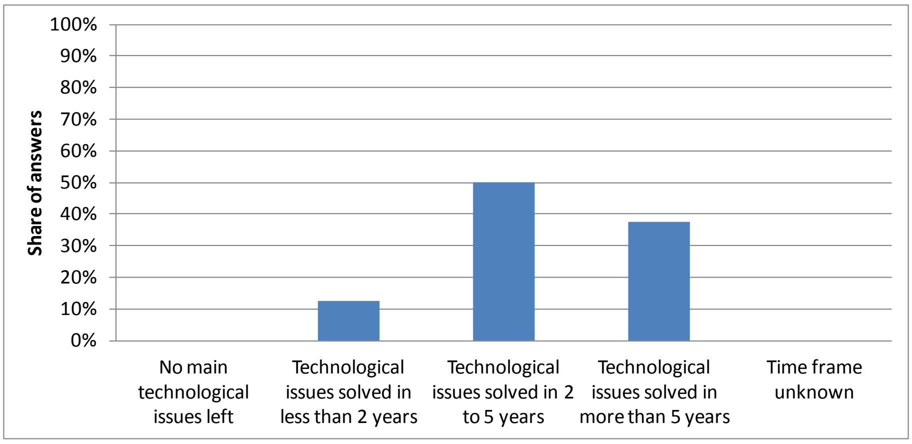
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong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



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:

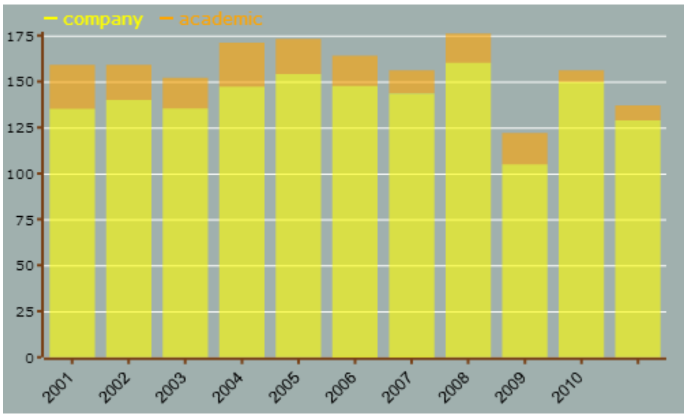


Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the short to medium term should be taken into consideration within this framework.

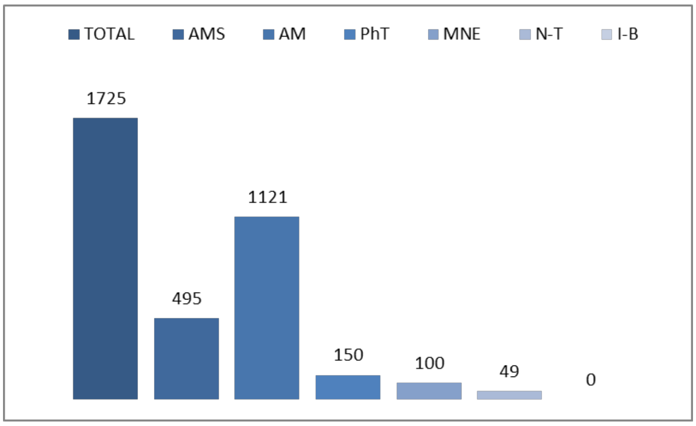
Additional information according to results of assessment:

- ***Impact assessment:***
  - Composites were first introduced into aerospace vehicles for weight reduction, with a direct link to energy efficiency. There is still a significant potential on this aspect, in all forms of transport, and this is considered as double environmental interest since most composites use carbon structures, potentially created from waste carbon rejects.
  - However the composite revolution is not just about weight and carbon, but it also opens new ways of designing vehicle structures, developing the material in parallel with the structure, looking for the right properties and shapes for the exact functional need at a given place in the overall vehicle design. This finally goes beyond composites and renews the approach for looking at more traditional steel or aluminium alloys (which benefit from nanoscience or new processes as net shape manufacturing, advanced joining/welding surface treatments and coatings).
  - Taking best advantage of composites or metal alloys, eventually integrating micro-devices or functionalization capabilities is nevertheless not always straightforward and strong efforts are needed to make sure new vehicle structures do not create safety issues (including with ageing), services offered by traditional materials (as Faraday cage effect of metal structures protecting against thunderbolt) are otherwise compensated and production capabilities in supply chains are able for ramp up when needed (consider Boeing 777 difficulties with composites supply, with volumes far from what would be needed by the automotive industry).
  - Systematic deployment of advanced vehicle structures means that quite traditional steel and aluminium industries have to adapt to a brand new world, and be partially replaced by new supply chains still not completely operational at sufficient scale. This is of high potential impact on European industry.

- ***Results of patents scenario analysis:***
  - 1725 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Stable trend curve (number of patents per year)
  - Highest share of industrial applicants, with the top 30 patent applicants being especially shared between large industries from Japan, Germany and France and (to a lesser extent) USA. These players are all large industries, either vehicle OEMs (Boeing, Airbus, Honda, Toyota, GE, Siemens, Daimler, etc.) or more chemistry and materials players (Bridgestone, BASF, Michelin, Bayer, Saint Gobain, Nippon Steel, Arkema, etc.).



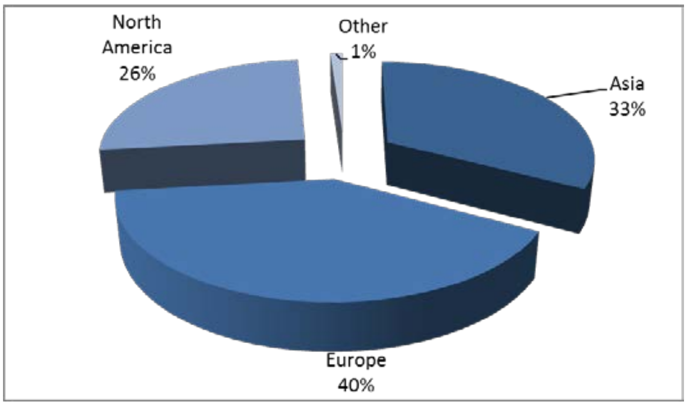
- Patents by KET(s):



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

KET(s)	*Number of patents*
AM	1121
AM / MNE	22
AM / MNE / N-T	4
AM / MNE / PhT	7
AM / N-T	44
AM / N-T / PhT	7
AM / PhT	29
AMS	495
AMS / AM	41
AMS / AM / MNE	4
AMS / AM / MNE / N-T	2
AMS / AM / MNE / PhT	1
AMS / AM / N-T	4
AMS / AM / PhT	1
AMS / MNE	17
AMS / MNE / N-T	2
AMS / MNE / PhT	4
AMS / N-T	4
AMS / PhT	8
MNE	100
MNE / N-T	5
MNE / PhT	43
N-T	49
N-T / PhT	7
PhT	150

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: