EuMaT

Topic call suggestion

Work Programme 2018 - 2020

Alliance for Materials

EuMaT Topic call suggestion Work Programme 2018 - 2020

Top Priorities Focus Areas for Work Programme 2018-2020

In this first set of proposed priorities we listed the five top priorities directly linked to Focus Areas relevant to Industrial Technology.

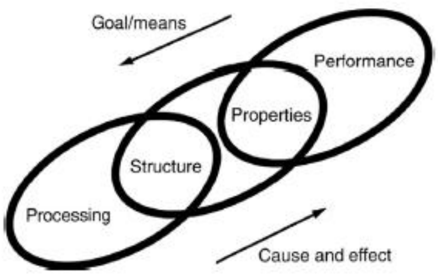
MODELLING

Title of proposed TOPIC
Materials Modelling CMD Initiative: Computational Material & Processing design, integrating materials engineering & Science

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

The specific challenge is to create Models that make it possible to understand the damage and degradation phenomena in materials at the microstructural level. There is a strong demand for Reliability and Sustainability of Functional and Structural Materials and Components by design. The key is to develop a computational material design tool based on microstructure, leading to the right, desired and required materials properties. The model should take into account the **integration of manufacturing steps into the full CMD** of components. The main barrier of actual Computational Material **Design tools (CMD) needs to be largely expanded and improved in the area of damage, degradation, and failure lifetime prediction, following the approach PSPP (processing–structure–properties–performance).**



Scope:

The understanding of the microstructures (for metals, ceramics as well as for reinforced plastics), modelling fatigue, functional and structural degradation caused by wear, damage, fracture and breakage, corrosion, ageing oxidation, thermal stress, flash temperatures, delamination (coatings), matrix failure or fibre fracture (reinforced plastics), separation matrix-particles (metal matrix composites), etc. Often materials microstructures and properties depend on manufacturing process they may have during their transformation to the components (forming, shaping, thermal treatment, welding and soldering, gluing, machining…). Also, it is largely unknown how the effect of working environment (such as oil, petrol, biofuels, lubricants, gases, humidity, water) should be considered in the prediction of their performance during use.

Laboratory accelerated tests should be combined with observation techniques and local knowledge on material behaviour in situ, under operating loads. Models should be robust and built on a strong experimental database. **There is a need to create models for multiple and combined damage and surface / sub-surface failure mechanisms considering materials properties, specific compound design geometries simulating their working conditions such as load, speed, fatigue stress or corrosion environment to predict their lifetime**

Expected Impact:

This approach will have a huge impact in the **valorization of EU Products** in comparison with low cost countries. Through good product design, European products enjoy high durability in comparison with low cost countries, but there still needs to be an increase in the durability of products to achieve customer guarantee requirements. Design of the materials depends on the conditions of use and durability requirements. If we know how to design the materials in the components for a defined lifecycle and application, then we could be confident, as suppliers and consumers, about the guarantee of a product's life and reliability. Applications needs always to limit the quantity of the materials used (Raw materials directive) and the weight of the components (reduce fuel consumption in transport), and increase performance, higher pressure and speeds (to reduce CO_2 emissions in transport), to increase safety (environmental compatibility and safe use). To achieve all these challenges, **we need to design tailored materials for their safe use during a predicted lifetime.** In general terms, we advocate ongoing and future research in **materials informatics**: combining experimental and theoretical high-throughput methods with data mining / machine learning

Why now

There is a **high demand** for new and advanced materials (functional, structural…). The methodology of choice is CMD, and the industry of Europe is ready to implement it. CMD, when reliably working "in place", has not only **effects on new products** (function, reliability, costs…) but also **on the R&D process:** an analysis of CMD effects on R&D pointed to the speeding up development time, **reduced experimental efforts,** and generally less **"search and fail".** The **benefit ratio was estimated at 3:1 (2004).** Materials Modelling and CMD can help **to bridge the gap** between Science, Development, and Production. CMD and model-based prediction can help to determine if **target performances** of specific **(structural and functional) materials can be reached,** and the degree of difficulty required to achieve them, if at all. In order to achieve these benefits, **massive research efforts are necessary,** which by **far exceed the capacities of individual research institutions and industrial players,** thus calling for joint research under H2020.

Benefits for EU Industries @ H2020:

Today, a very small proportion of materials are designed by modelling and computational methods. Public funding can help to overcome important barriers in CMD and ease the way to broad application of CMD for many INDUSTRIAL USERS. If in future **Open Source models** (with standard descriptors) and material data bases become available and accessible, CMD will be widely used in many industries and engineering services, including SME's. New models **could produce design data** that is non-proprietary to contribute to design guides such as those produced by ESDU. **Reliable and cheap modelling** with efficient, focused materials-development processes will then allow for a much wider wide range of applications designed by CMD. This **includes processes, components and systems** with superior performance, and applications that are today out of reach or unthinkable. The impact on **technology and business** in Europe will undoubtedly be very high

HEALTH

Title of proposed TOPIC
"Living implant" scaffolds for cardiovascular application

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Cardiovascular diseases represent the leading cause of mortality worldwide. Very often the etiology of the disease relies on a damaged or failing tissue (e.g. vessels, heart tissues and valves) and a definitive solution is still missing. Medical treatments usually aim at limiting the disease progression, whereas surgical or interventional approaches entail the use of prostheses which highly affect the patient quality of life.

Inert materials used in cardiovascular implants do not growth with the patient and lead to life-long biocompatibility issues; grafts lead to rejection due to immunologic barrier and progressive degeneration, especially in younger patients. Tissue engineering and regenerative medicine are emerging multidisciplinary fields in rapid growth over the last 10 years, focused on innovative biomaterials, molecular and cellular biology, and design engineering. Their main objective is the creation of functional, living tissue constructs that can reestablish the structure and function of the injured tissues, thus overcoming the limitations of the current clinical approaches. The emergence of innovative biomaterials, able to interact with the body cells, has revolutionized the field of biomedical research. As such, biomaterials are central to many strategies focused on localized delivery of bioactive moieties, and on scaffold engineering. An ideal scaffold for tissue engineering should be bioresorbable, biocompatible and with highly porous macrostructure necessary for cell repopulation, growth, nutrient supply, and waste removal. In particular, in order to interact with living cells some features of the native 3D tissue environment associated with their renewal, differentiation and organization have to be mimicked in the target scaffold materials. The ability to manipulate cell-substrate interactions at the micro/nano scale may represent the key to achieve a viable cellular environment which can be effectively integrated with the host tissue.

The specific challenge is the development of "living implants" with the potential to grow and last during lifetime, like most native tissues do, by exploiting the unique properties and phenomena exerted by matter at the nano-scale.

Numerous scaffold fabrication technique are already available, however the accurate control of the spatial distribution of pores, 3D pores architecture and structures within the scaffold is still an open challenge. Promising technique are represented by Additive Manufacturing (AM) processes (e.g. fused deposition modeling, 3D/4D printing, selected laser sintering, stereolithography and inkjet printing) in which structures are constructed layer by layer according to computer aided design. The recent application of AM principles to electrospinning techniques has allowed to obtain smaller fiber resolution in comparison to what achieved with conventional AM techniques as well as to enhance the control over electrospun fibrous assembly in terms of interfiber pore size and geometry, sample thickness and external shape.

Scope:

Aim of this call is the development of an innovative biocompatible "living implant" for cardiovascular application, obtained by exploiting the latest advances in nanomaterials and nanotechnology. Porosity, pore size and inter-pore connectivity represent essential design features for a modern scaffold. The attempt must focuses on the realization of a scaffold with controlled porosity, surface chemistry and structure so that it can successfully induce new tissue development and growth. Biodegradability issue should be considered in order to control the degradation rate of the scaffold and the mechanism involved. The degradation of the scaffold should take place at rate equal or lower than that of new tissue formation process, since the scaffold should retain the necessary mechanical properties and provide the temporary support structure needed for tissue/organ functioning prior the complete tissue formation.

Moreover the in vivo degradation of a polymeric scaffold leads to the creation of low-molecular-weight degradation products within the body tissues, the effects of which must be considered. Neither the scaffold material itself nor its degradation products should have local or systemic toxic effects on the host cells.

Proper functionality and durability shall be pursued in order to avoid the fate and the failure mechanisms commonly reported for current bioresorbable approaches applied to heart valves – mainly known are fibrosis, retraction and incompetence.)

Advanced techniques of rapid prototyping allow the realization of scaffold without the need of templates and provide precise control over scaffold architecture. The integration of this techniques based on additive manufacturing processes shall enable the design of morphology-controlled scaffold, potentially even in a custom made fashion.

Furthermore the recent application of AM principles to electrospinning techniques has allowed to obtain smaller fiber resolution in comparison to what achieved with conventional AM techniques as well as to enhance the control over electrospun fibrous assembly in terms of interfiber pore size and geometry, sample thickness and external shape. While significant progress towards the development of predesigned constructs composed by ultrafine fibers made of synthetic polymers has been achieved, mainly by means of melt processing, innovative solutions for electrospinning as an AM approach to produce biobased polymeric constructs appear to be at present of utmost interest in the area of smart biomedical devices.

Biobased polymers (with structural relationship to biopolymers that constitute the building blocks of living organisms) or synthetic solutions could be developed and both in vitro cell seeding (i.e. before implantation) and in vivo cell repopulation (after implantation) could be pursued.

Moreover the use of cold plasmas technologies could allow to modify and functionalize the surface of the scaffolds (e.g. by tuning hydrophobic or hydrophilic properties or through the immobilization and/or embedding of biomolecules). Penetration of active species in the scaffold can be optimized by properly tuning plasma parameters such as plasma regime, pressure, applied power, feed gas composition, and others.

Proposals activities should lead to high degree of automation and quality control on lab scale of cost-effective manufacturing processes that can be easily translated to industrial scale.

The above mentioned materials and technologies should specifically target to the cardiovascular field, but could be further exploited in other areas.

In order to ensure industrial relevance and impact of the research efforts, active participation of industrial partners represents an added value to the proposals and this will be reflected in the evaluation.

Expected Impact:

- Definition of new advanced biomaterials/implants with specific and innovative nano/micro-scale properties.
- Development of a "predictable/controlled biodegradation scaffold" for application in cardiovascular field.
- Development of a "living implant" with the potential to grow and last during the whole lifetime and without the current drawbacks of grafts and prostheses.
- Face the unmet need of young patients to reduce/avoid re-operations during their lives increasing also the use of personalized therapies.
- Exploitation of highly innovative technologies for new applications in biomedical field.
- Enabling Europe to compete at the forefront of the AM revolution also minimizing waste and the use of resources (eco-sustainability).

- Increase in competitiveness of the biomaterials and biomedical industries in the EU and open new markets.
- Promoting safe-by-design approaches in collaboration with the EU nano-safety cluster.
- Collaboration with the Authorities operating in Healthcare in the definition of the regulatory perspective for this new class of products.

ENERGY

Title of proposed TOPIC
Low cost printed electrochromics and batteries integration in printed electronics

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Next generations of electronics will be printed on flexible films and even on paper. The benefit is less weight, less consumption of materials, high throughput production in role-to-role or sheet-to-sheet technology and easy and flexible design. There have been worldwide R&D programs and calls towards printable electronics, even printable batteries and electrochromics, but up to now there are not existing tuned materials and technologies which allow a synergetic merge of manufacturing a printed display, needed electronics and power supply in one line at low cost. New patternable ion storage materials, polymer electrodes and electrolytes with defined interface as well as dielectrics and packaging/passivation materials which are in addition disposable and/or recyclable are searched for. The last decade approve, that nano-scaled inorganic-organic hybrids have the potential to be a general matrix for hosting functional (nano)particles as well as (active) organics and dyes. The challenge is to adapt these existing active/passive materials to be hosted and processed in that class of matrix materials allowing a standardized low cost printing to get systems including e.g. all-organic and/or hybrid printed batteries, switchable devices and electrochromic displays in low-cost by use of high- throughput manufacturing.

Scope:

The proposal should address the engineering and chemical challenges linked with synthesis and processing of nano-scaled hybrid multifunctional materials (matrix, particles and dyes) and must include a careful analysis and optimization of the interfaces, depending and resulting on functions and processing of the printed system. The proposal must also consider the use of new sustainable routes in chemical processing and electronic and mechanical engineering.

Expected Impact:

The hybrid nano-scaled matrix concept and the resulting devices should give the base for a sustainable low-cost platform for easy printing of a variety of electronic devices including their power supply within one process and line.

- The chemical synthesis of the nano-materials and the investigation of the interphases to matrix and printed function should lead to a better understanding of packaging and integration in printed electronics.
- The careful focus on sustainability should enable lower cost production, less use of material and better design for circular economy.
- The use of a unique matrix for packaging of all system-components allows high system integration and standardization of the printing process.
- As there will be only on the one side the nano-inks for matrix, active and passive functions as well on the other side the 2D- and/or 3D printing equipment, new flexible production and company concepts should result, as electronic systems will not be designed/assembled by components, they will be designed and produced by chemical source and limits of the printing technology.
- New types of electronics, photonics, displays, sensors, smart systems could be the output.In long-term this matrix and printing concept could be upgraded from role-to-role to high resolution 3D printing of complex autonomic electronic and photonic systems.

ADDITIVE MANUFACTURING

Title of proposed TOPIC
Additive Manufacturing with Carbon Fibers and Polymers

Challenge, Objective and Impact of proposed TOPIC

Specific Challenge:

Carbon fiber reinforced lightweight structures are actually the most important substitution material for structural applications with low mass, high stiffness and strength. The ability to use the specific anisotropy of the reinforcing fibers offers additional potential for custom-tailored load applications in terrestrial and air traffic as well as in in buildings, engineering and energy applications.

From cost and efficiency aspects, the infiltration process of a textile reinforcing architecture with a polymer or the polymerization of monomers to macromolecules within this textile structure is the key process for process optimization.

The direct formation of near-net-shape structural components from endless and/or short carbon fibers in combination with the polymer similar to the classical 3-D-printing process still is a technical challenge.

The direct wetting of carbon fibers with polymers when forming the final textile architectures is a process that up to now is a special subject perfectly handled by spiders when spinning their web.

Scope:

Focusing on novel matrix polymers optimized for these special process technologies of carbon fiber reinforced composites will offer new options and challenges. Designed molecular structures with high compatibility to reinforcing fibers, combination of organic and inorganic polymer structures, new hybrid polymers (inorganic and organic parts blended on molecular level), increased application of cellular polymer materials (open or closed foams) and gradient materials and sandwich materials based on folded structures should/may have essential impact on new applications.

Expected Impact:

- Weight reduction compared to classical materials > 40%;
- Process cost reduction from currently 75% to 25% of the total carbon composite costs;
- Cost reduction from 30-50 €/kg to 15 €/kg for the composite material;
- Potential for new material design with further cost reduction equivalent of < 15 €/kg by material property related parameters (strength/stiffness per cost) similar or better than aluminum;
- Potential for new polymer systems for additive manufacturing concepts;

CIRCULAR ECONOMY

Title of proposed TOPIC
Zero-waste exploitation of mining waste

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

As stipulated in the Strategic Implementation Plan (SIP) for the European Innovation Partnership on Raw Materials (EIP RM), the EU is highly dependent on imports of raw materials that are crucial for a strong European industrial base, an essential building block of the EU's growth and competitiveness. The increasing demand for unprocessed minerals and metals and volatility in the prices of certain raw materials, as well as the market distortions imposed by some countries on a number of them, have shed light on the importance of raw materials for our economy and society. The specific challenge is the zero-waste exploitation of mining waste, with a particular focus on tailings, which are ubiquitous in Europe. Zero-waste schemes are needed where base and critical metals are recovered and residuals are remediated and valorised, using eco-friendly and cost-effective technologies. Sustainable mining and recycling are key for feeding and closing cascaded material and product cycles in a viable, growing circular economy.

Scope:

Novel metallurgical and thermomechanical routes must be developed and integrated for the valorisation of fresh flows and historical stocks from copper, lead/zinc, cobalt, gold, nickel, magnesia etc. containing tailings. Solutions should respect the zero-waste principle so as to recover not only the critical raw materials (REEs, indium, germanium, cobalt, PGMs, etc.), but also the base metals, using combinations of advanced pre-treatments and hydro-, solvo-, bio-, electro- and pyrometallurgical methods, and subsequently safely remediate or even better valorise the cleaned residual minerals (> 99wt% of the initial mass) into engineering materials with enhanced properties, e.g. for construction purposes, technical ceramics or composite materials. This challenge can be met only by the participation of industrial partners along the full 'secondary mining' and mine reclamation value chain.

Expected Impact:

- Rising to the challenge will push Europe to the forefront in the areas of comprehensive, zero-waste metal recovery technologies for complex multicomponent, low grade tailing sources and similar including landfills and fresh flows and stacks of industrial residues (sludges, ashes, slags), unlocking a substantial volume of both critical metals, base metals and minerals within the EU, taking into account the presence of numerous tailing deposits scattered all over Europe
- Avoiding future remediation costs of contaminated mining sites containing toxic substances. Mine reclamation subsequent to tailing valorisation creates useful landscapes that meet a variety of goals ranging from the restoration of productive ecosystems to the creation of industrial and municipal resources.
- Improved economic viability and investment security of mining operations.
- Improved competitiveness and creation of new jobs in metal processing and downstream industries, incl. e.g. low-carbon building material producers.
- Overall: sustainable mining and recycling in a circular economy context.

Priorities for Work Programme 2018-2020

This second list proposes others topics, most of those still directly linked to Focus Areas, but proposed as further options to be considered.

Title of proposed TOPIC
1 - Hybrid Materials for Lightweight Constructions

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

The actual trends in Hybrid Composite Technology offers a reasonable chance to realize lightweight constructions with acceptable cost. The combination of metal structures with fiber-reinforced composites enables the designing engineer to generate new concepts for load-bearing configurations. High-strength metals and alloys are limited in stiffness. The force-locked joining of metals with carbon fiber reinforced polymers compensates this disadvantage. An economic technology for processing of Multi-Material-Structures still is missing.

Scope:

Design-optimized hybrid structures with load-adapted components by complete or local CFRP strengthening offering the high potential for lightweight construction. Alignment the reinforcement to highly stressed areas and specific load cases. Developing and realizing bonding strategies for force-locked combination of metal structures with fiber reinforced polymers. Development of process-optimized polymers for adhesion and as matrix system for the composite. Integrative processing of metal and fiber structures to reduce cost and energy use. Integration of sandwich structure to foster weight reduction. Concepts for in-situ process and quality controlling. Design for recycling in using novel polymer systems with the high performance properties consistent with thermosets under a wide range of conditions, and the ability to be welded, mended, reshaped, or completely degraded to their constituent monomers upon a specific stimulus. Correlation of corrosion mechanisms with the process-structure-property relationship and fatigue behaviour. Optimizing cathodic dip painting process to enable industrial-scale corrosion protection treatment.

Reduction of cycle-time with process-optimized polymer systems. Using residual energy for polymer processing out of the thermal metal forming processes.

Expected Impact:

CFRP reinforcement in sheet metal structures offers a high weight-saving potential. The potential reduction of weight against steel is 35 % or higher. New design concepts based on reduced thickness and higher stiffness offers further cost saving options. Applying CFRP on highly loaded areas in the structure reduces total material costs. Simultaneous hot forming of metal and CFRP helps to reduce energy costs for the curing process of the polymer. Hybrid materials in future will play an essential role in transportation, machinery and civil engineering.

Title of proposed TOPIC
2 - Smart solar harvesting by design for energy efficient buildings

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

On a global scale, buildings (both residential and commercial) account for 35-40% of total final energy consumption. With the continued challenge of climate change, more measures have to be implemented that will reduce energy consumption and GreenHouse Gases (GHG) emissions so to meet COP 21 (2015 United Nations Climate Change Conference) goal of limiting global warming to less than 2 degrees Celsius compared to pre-industrial levels. The increasing deployment of energy efficient commercial and public buildings provides an important pathway for increasing energy security, reducing – or even decreasing – energy demand, reducing GHG emissions, and reducing demand for new energy production and distribution facilities. Energy efficient buildings can also be used by commercial building owners and tenants to support greening and green marketing efforts. Focusing on the building envelope, smart windows, along with insulation systems, will be the key measurement among other retrofitting ones.

With an increased awareness of environmental issues, there is a challenge for physicists, chemists and engineers to develop new products, processes and services that achieve critical societal, economic and environmental objectives. Green Technologies and Green Engineering are the answers of the scientific community to that challenge.

This call will give priority to the design, delivery, implementation and optimization of building concepts that have the technical, economic and societal potential to drastically reduce energy consumption and decrease CO_2 emissions, both in relation to new buildings and to the renovation of existing buildings giving emphasis to smart windows and glazing.

Although currently many functional materials have being investigated and a number of smart windows are available on the market, there is a strong need to develop reliable and affordable advanced materials which exceed the performance of presently used materials, and also respect strict sustainability principles.

Scope:

The goal of the call is to develop and characterize new materials with ad hoc functionalities and/or improving existing ones using nanotechnologies based on atomistic models, interface effects, chemical entities, etc. Energy materials by design will employ scientific principles in deliberately creating structures with (nanoscale) features (e.g., size, architecture) that deliver unique functionality and utility for smart window applications along with environmental safety.

While advances in technologies including synthesis, manufacturing, and characterization are very important factors in realizing this target, an overarching strategy and rational design framework is of paramount importance. This may involve integration of modeling and simulation methods with theory, experiment, and the transformation of the resulting information into knowledge, which is then applied in processing and manufacturing.

Key to this approach is the use of dedicated software — modeling, simulation, and informatics tools. This engineering-driven approach to safe energy materials by design, focused on applications and spearheaded by software, is rational smart windows design.

The overall objective of the call is to design and develop high performance smart window system based on functional strongly correlated materials, solid-state electrolytes, able to improve thermal resistance of window system and to control the adaptive solar control.

Expected Impact:

- Definition of new advanced functional materials with specific and innovative solar control properties.
- Development of predictable/controlled smart windows for application in old and new commercial and public buildings.
- Technologies by design which are reliable and ensure a minimum of 15 years life time.
- Reduction of at least 60% in energy consumption in buildings.
- Demonstration of co-benefits which can have an impact on the real estate value of such buildings and on living/occupancy standards.
- Exploitation of highly innovative technologies for new applications of solar control coatings and devices.
- Enabling Europe to compete at the forefront of COP21 minimizing energy in buildings and the use of resources (eco-sustainability).
- Increase in competitiveness of glass industries for building sector in the EU and open new markets.
- Promoting safe-by-design approaches in collaboration with the EU nano-safety cluster.

Title of proposed TOPIC
3 - New Materials Design and Technologies for Cultural Heritage Valorization and Preservation

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

The widespread presence of movable and immoveable cultural assets in the European Union, their high cultural value and the accessibility and fruition of this heritage by the public, make crucial the necessity of their sustainable management and protection. This necessity is amplified by the relevant economic importance that cultural assets have for Europe. Also social benefits derive from the direct use of the resources (visiting historic cities, buildings, monuments, archaeological sites, museums) or from the knowledge that CH exists and that it will be available for future enjoyment by all. According to the study "Creating growth. Measuring cultural and creative markets in the EU", commissioned to EY and published in December 2014, culture is one of Europe's greatest assets, helping to brand cities and regions, attracting talent and tourism. Also the investment in conservation activities, economically benefits the companies involved in the sector. The drawback is that the high demand on cultural heritage by visitors affects the cultural places and it is urgent to protect cultural heritage as it is the protection of our own European cultural identity for present and future generations.

The specific challenge is the development of materials and the application of technologies for cultural heritage preservation and valorization, raising at the same time stakeholders and society awareness for the need of technical and scientific development in restoration and conservation practices. Although materials exist dedicated for the application in cultural heritage, new eco-friendly and diverse compatible solutions have to be developed along with studies on the effects that the application of such materials have on monuments and artefacts.

Scope:

The aim of this call is the development of innovative and eco-friendly solutions for the mitigation of anthropic, environmental and pollution impact on cultural heritage assets by exploring the latest technical and scientific advances available.

Such development must be based on new materials designed by means of an integrated chemical and engineering approach for the application on CH. There will be a necessity for low material and visual impact, performance improvement and addressing the use of environmentally and health friendly approaches. It will respond to the need of eco-sustainable and energy efficient materials and strategies for the long-term maintenance and restoration of CH. It will set-up specific guidelines for long-term prevention and maintenance actions, able to account specifically the CH site features and the risks affecting it, and for the operational procedures for risk management. Strategies and tools will have to be developed to promote results to a widespread arena of recipient communities. The effectiveness of the solutions will have to be demonstrated and a database delivered that can be queried by the different stakeholders as scientists, structural engineers and managers of CH. In order to ensure industrial relevance and impact of the research efforts, active participation of industrial partners represents an added value to the proposals and this will be reflected in the evaluation.

Expected Impact:

- Improving effectiveness and sustainability in terms of long-term maintenance actions.
- Diagnosis and treatment and a better understanding of the historical and technological contexts of heritage materials, technologies and objects.
- Increasing awareness on Cultural Heritage challenges, best practices, research, and adaptation.

- Changing and improving CH management practices and policies.
- Identifying adaptation and restoration measures specifically thought for CH assets.
- Carrying out a performance analysis of adaptation and restoration actions and assessing the necessity to develop and implement new or improved materials and methods.
- Improving risk management.
- increased collaboration and cooperation between CH stakeholders and fostering an interdisciplinary approach.
- Proactively addressing the needs and requirements of users, such as decision makers at local, regional, national and international level responsible for the safeguarding of CH assets.

Title of proposed TOPIC
4 - New CSA Establishing a road-map for Regional collaboration on smart specialization (Sm-Sp)

Challenge, Scope and Impact of proposed TOPIC

Specific challenge:

The key issue behind the difficulties on the exploitation, for the vast majority of European funded innovative results, is the luck of concerted actions that would promote these results in the context of a well-defined value chain. Fragmented exploitation actions so far have failed to integrate or translate to the needs of a specific KET as a result of which many novel ideas and innovative results are getting diffused and eventually faint in a maze of dazzling opportunities.

Through Smart specialization (Sm-Sp) initiatives, the European Regions have a unique opportunity to direct their local funds, expertise and knowhow to actions that may create the maximum of economic and development impact. However for such an effort to have any realistic chance of significant effect on their economies, a concerted action with strong "thematic focus" should be undertaken mobilizing a critical number of "contributors" that could enhance Sm-Sp of the said location. Thus, the emphasis should be placed on integrated and concerted business activities on added value investment opportunities with a "thematic focus". Such an outcome of concerted action could take place either around an existing or a newly developed geographical location in an EU Region that provides the required infrastructure that minimizes running costs while maximizes the prospects for business growth and job creation.

Scope:

A study on best practices that would encourage the promotion of cooperation among Regions who share parts of the same technology and product line, enhancing defined value chains as part of cooperation of Regions and their own companies that share the same or at least have complementing research and industrial thematic goals. This may, for instance, be achieved my promoting the formation of strong Sm-Sp networks that target the quick technology transfer from R&D Institutions to the value-chain of collaborating partner companies under a concerted and coordinated manner.

Expected impact:

The project should deliver answers to the following questions:

- What scenarios can be expected and under what conditions future thematic value-chains on Regional Sm-Sp may be established and in which timescales?
- What are the expected tangible and intangible results of such an exercise?
- What effect such a concerted action will have of growth and job creation?
- What would the added value be for the local and EU economy?
- What effect such initiatives have on cohesion and integration within EU?
- What message one would expect for creating "thematic development zones" in selected EU Regions
- <u>Type of Action</u>: Coordination and support action

Title of proposed TOPIC
5 - Advanced Sorbent materials for air de-pollution

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

The atmosphere is constituted mostly of nitrogen (N2) (78%), oxygen (O2), essential for our lives (21%), and 1% of other gases (as rare gases like argon, krypton or xenon). The quality of this air, that we breathe, is of a prime importance but affected by our modern society. Air pollution is both environmental and social problem as it affects human health, ecosystems and plays a key a role on climate change and global warming. According to the World Health Organization (WHO), in urban areas monitored for air pollution, more of 80% of people are exposed to air quality levels that exceed limits either for particulate matter, ozone, NO2 or SO2 (their limits have been fixed to 10-20 μg/m3 annual mean, 100μg/m3 8hours mean, 40 μg/m3 annual mean and 20μg/m3 24 hours mean, respectively). Air pollution is accused to be responsible of substantial premature death causes by heart disease, stroke or lung diseases. Two reports from International Agency of Research on Cancer (IARC) from 2013 and 2015 are dedicated to the relationship between cancer and air pollution classifying it as carcinogenic for human and animals. These effects on human health make considerable impact on economy by reducing productivity, increasing medical cost and cutting lives short. According to the European Commission, in 2010, the total of health-related external cost due to air pollution in Europe has been estimated in the range of 330-940 billion euros per year. This same report assesses to 3 billion euros the cost of crop yield loss. Indeed, air pollution affects directly vegetation as well as water and soil quality. The resultant eutrophication causes modifications in species diversity and invasions of new species. There is a wide array of hazardous pollutants that can be natural or anthropogenic. They are mainly emitted by the burning of fossil fuels used in electricity generation, transport industry and household, but also by sectors like agriculture and waste.

One of the most promising technologies is based on the adsorption process using a specific porous material called sorbent. The advantages of this technique are that it is a low cost and quite easy to operate method. The principle of adsorption is based on the ability of the sorbent to **selectively adsorb specific gases and vapors** depending on their size, shape, affinity with the host-framework and/or polarizability. Depending on the interactions between the sorbent and the adsorbate, the adsorption can be chemical (a chemical reaction occurs between both) or physical (the guests are trapped in the pores thanks to weak forces without modifications of itself or the host). The later process is more favorable since the regeneration of the sorbent is much less energy demanding because of the weak interaction between the host (sorbent) and the guest (gases or vapor).

Various sorbents have already been studied for the adsorption of hazardous gases and vapors like activated carbons, mesoporous materials or zeolites. However their performance is limited and therefore the development of novel and more efficient sorbets is important.

Scope:

The aim should be the development of novel porous materials taking into account the following:

1. Are composed from environmental friendly elements with moderate natural abundance to reduce the production cost
2. Production methods meet the basic rules of green-chemistry and in particular, the use of water as solvent
3. Display a high thermal and chemical stability under working conditions
4. Are composed of tunable pore size and shape, allowing either kinetic or molecular sieving mechanism
5. Display control over hydrophobicity / hydrophilicity

Title of proposed TOPIC
6 - Corrosion-free Light Weight Concrete Structures

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

The remaining corrosion-free service life of all existing steel reinforced concrete in buildings, bridges and other infrastructure is one of the big topics of today's economic communities. The financing needs for restauration or reconstruction means a significant risk for future economic growth strategies. The handling of the aging public and private infrastructure under resource management points of view is a very critical topic.

The civil engineering by using materials for the building production stage without any regard on reducing the overconsumption of materials actually contributes significantly to the decrease of materials and energy resources. Based on missing or not noticed alternatives a drastically short time change is not visible. Nethertheless first options were available in the last years.

The substitution of steel mats by carbon fiber based knitted fabric (Carbon Fiber Textile Concrete) and the use of adhesive bonded carbon fiber laminates for repairing or additional reinforcement are the first step in the right direction.

Another more effective way is the new basic approach not only to substitute the steel but also to generate new construction options with carbon fiber reinforced polymer components. These carbon fiber reinforced polymer (CFRP) components combined with carbon fiber textile reinforced concrete will offer a new dimension for additional mass reduction of the concrete itself. They also can include new concepts for a quick and economic repairing of existing concrete structures to extend their lifetime.

There still exist only minor experience with prototypes using CFRP as load-bearing structure in combination with concrete.

Scope:

Systematically analysis of architectural structural parts in civil engineering for weight reduction.

Concepts for combining CFRP-loadbearing structures and profiles with classical concrete elements. Defining CFRP load application elements for combining loadbearing structures with ceilings, columns, with other CFRP and concrete parts. Evaluation of design options and criteria for using the following CFRP elements in combination with concrete structures:

- CFRP beams
- CFRP plates
- CFRP ropes
- CFRP sandwiches
- CFRP-wood laminates
- CFRP-wood beams and wood tubes
- CFRP-metal laminates
- CFRP load application elements

Development of concepts for risk management consisting of risk assessment and risk control for existing aging structures and repair options correlated to new CFRP / Carbon Fiber Textile Concrete structures. Estimation of damage tolerances, lifetime parameters, performing Life Cycle Assessment (LCA) and developing recycling / reuse concepts.

Expected Impact:

New constructions and maintenance principles, as well as new repair and rehabilitation methods of existing structures, will help us to avoid or stop the aging processes of the infrastructure.

Considerable reduction of material use for civil engineering. Significant lower material weight with significant diminishing the energy use for the building production stage.

Potential for further intelligent material combinations of CFRP / Concrete with foams, vacuum glass beads, erosion coatings and others to decrease energy requirements utilization of the civil engineering objects.

Title of proposed TOPIC
7 - Wear and oxidation resistant coatings for intermetallics belonging to Ti-Al system

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Titanium aluminides have been investigated since the seventies because of their interesting properties (lightweight and specific strength and stiffness) but only recently they have found industrial applications for components of turbine blades of aircraft engines and turbochargers of vehicles. Advances in the control of the microstructure, microalloying and thermal treatment of new alloys, which show improved mechanical behavior at high temperature as well as better ductility at room temperature, made possible these applications. Efforts are currently spent with the aim of increasing the operation temperature and the performance of this class of intermetallics. Two main concern deal with the wear and oxidation behavior at high temperature. Wear resistance is required for some parts of turbine blades (z-notch) while oxidation resistance is required because of the oxidizing environment and high temperature characteristic of turbine operating conditions. Oxidation resistance of Ti-Al alloys has been already improved by using proper alloying elements like niobium but it seems hard to get further advances in this manner. During the evolution of aeronautics the working temperature of turbine engines progressively increased and the properties of the materials traditionally adopted for this application (typically superalloys) were progressively enhanced by using alloying elements and tailored production processes. Nevertheless the most recent improvement in this field were achieved by adopting thermal barrier coatings (TBCs). TBCs are designed taking care of keeping the thermal stress (arising from the thermal expansion mismatch between the alloy and the TBC) as little as possible. The same route should be exploited for extending the operation temperature range and the lifetime of intermetallic alloys. Different tailored coatings are also usually deposed on parts of the turbine blade suffering wear, and these coatings are required to face oxidation at high temperature too.

Structure and composition of new protective coatings (wear and oxidation resistant) as well as their fabrication processes should be specifically designed for the protection of titanium alluminides. In fact the coating technology already well established for superalloys cannot be simply transferred to Ti-Al alloys because of their different chemical composition and thermal properties. New kinds of coatings compatible with the thermal expansion of titanium aluminides and showing both wear resistance and passivation at high temperature should be developed.

Scope:

Aim of this call is the development of specific coatings designed for enhancing the wear and oxidation resistance of intermetallic alloys belonging to Ti-Al system. These alloys have found industrial application for the production of turbine blades of aircraft engines and are very promising for applications in automotive (turbocharger wheels). Currently the maximum operating temperature for the intermetallic blades is about 750° C, but higher temperatures could be experienced by components of hottest stage of turbine engines as well as in the car engine. For this reasons to date some researches are aimed at the development of Ti-Al alloys able to operate at higher temperature. The mechanical features required for working at enhanced temperatures could be achieved by using proper alloying elements and alloy microstructure. Even though the Ti-Al alloys show not bad oxidation resistance owing to the presence of aluminium, the addition of alloying elements entails some concerns about the oxidation behavior of new intermetallic alloys designed for application at higher temperatures. In addition also wear and erosion resistance is required for the applications mentioned above. Surface coatings specifically designed for providing protection of these materials should be developed. These coatings should be light, hard, able to give a passive protection layer after oxidation and should be also compatible with the intermetallic substrate. In fact the application at high temperature requires good resistance to thermal shocks, that should not results in loss of adhesion at the interface coating-substrate. The attempt of the research should focus on the processing of not porous and hard coatings with composition and thermal expansion not too far from that of the intermetallic alloy. Preliminary researches showed that aluminium-based nitrides deposed by HiPIMS could match these requirements. The systems under investigation should be validated by tests simulating the real operating conditions. In order to ensure industrial relevance and impact of the research efforts, active participation of industrial partners like alloy manufacturers and prospective end-users would represents an added value to the proposals.

Expected Impact:

- Development of new coatings specifically designed for the surface protection of alloys belonging to Al-Ti system.
- Development of coatings, and relevant production processes, able to improve both wear and oxidation resistance.
- Tailoring these coatings for the intermetallic alloys currently used for industrial applications, and for alloys under consideration for application at higher temperatures as well.
- Validation of the technology by tests simulating the real operating conditions.
- Promoting a wider use of light materials (like intermetallics) for propulsion, which should result in decrease of fuel consumption and CO2 emissions (eco-sustainability).
- Filling the gap about the exploitation of Ti-Al alloys still existing between European industries and foreign competitors (e.g. USA)
- Exploitation of highly innovative technologies for new applications in transport and energy production fields.

Title of proposed TOPIC
8 - Pyrolysis of Waste Material for Recovering Raw Materials

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Pyrolysis is a thermo-chemical technology to disaggregate synthetic organic and biomass materials without oxidation and separating metals and inorganic substances. It offers i.e. the possibility of recovering metals out of Waste Electrical and Electronic Equipment (WEEE) parallel producing pyrolysis oils, liquids and high energetic gases. The liquid and gaseous organic products helps to keep the thermal treatment process ongoing. These pyrolysis products additionally extracted by distillation and converted into monomers allows combining them to new organic materials like polymers.

A breakthrough of this technology still depends on answering open technical questions concerning a closed energy balance for all pyrolysis products (solids, liquids and gases).

Scope:

Technology transfer from original application in coal processing to a modern technology for recovering metal, inorganics, oils, liquids and gases. Investigation of the multifunctionality of the most promising rotary kiln reactor type and similar types with a perfect heat distribution in the mixed pyrolizing material. Adapting the reaction parameters like temperature gradient, oxygen concentration gradient, residence time and turbation to the type of pyrolysis material.

Defining modes for autothermal and exothermal operation with energy surplus. Using and describing the options of steam cracking for getting additional efficiency in dismantling materials and using the following products like synthesis gas. Checking the possibilities to influence the reaction pathways by catalytic admixtures.

Correlating pyrolysed material and the resulting solid, liquid and gaseous products with the origin of the waste material (automotive, electronics, biomaterial, civil engineering and others). Describing the energy and material balance for the total process from raw material to a product and the following reuse procedure.

Defining criteria for tailored polymer structures prior suitable for thermochemical degradation at moderate decomposition temperatures. Elaborating energy balance topics confirming the efficiency of the process.

Including the thermal treatment of carbon fiber reinforced polymers (CFRP), hybrid structures (CFRP/metals) and polymers with high temperature stability as well as those with flame retardants and plasticizers.

Expected Impact:

Multiple pathways of possible pyrolysis reaction with admixture of steam and/or catalysts will offer additional options for raw material recovery under favorable energetic conditions. The possibility of defining tailored polymer structures for easy autothermal or energy surplus degradation will trigger a breakthrough in intelligent recycling and utilization of chemical products and their basic components.

Title of proposed TOPIC
9 - Bio-inspired smart advanced nanomaterials and nanostructures

Challenge, Scope and Impact of proposed TOPIC

Specific challenge:

Biological structures, optimized over millennia are an inspiration for the creation of novel and advanced multifunctional materials. Biological organisms evolution within specific environmental constraints result into too elegant and efficient strategies for fabricating bioinspired synthetic materials whose structure, properties or function mimic those of natural materials or living matter capable to outperform conventional materials or structures of similar composition.

While many organic molecules are already being considered, in some cases the use of inorganic materials will lead to better performance that those obtained using organics materials or even inexistent functionalities, when considering electronic or photonic applications, for instance. The great challenge lies on mimic the bio-inspired structures on advanced functional inorganic or hybrid materials, namely in what relates to composition, processing (self-assembly, hierarchical organization, …) and properties of bio-inspired materials - and use this information to synthesize and engineer novel functional materials for a variety of practical applications.

Scope:

The proposal should address the engineering challenges linked with processing bio-inspired nanostructures exploiting the advantages in using hybrid/inorganic multifunctional materials that can be accomplished using existing organic ones as the template. The proposal must also consider the use of new sustainable routes and abundant and cheap materials in order to create hierarchical and mesoporous structures able to generate a plethora of low cost, sustainable and disposable electronic and optoelectronic devices such as bio detection systems, bioelectronics bio-optics, among others.

Expected Impact:

These bioinspired concepts when integrated into materials and devices are intended to result in advanced on the consumer, industrial, medical, military and energy sectors.

- Create low-cost and bio-compatible functional systems with sensing and actuation by mimic many phenomena exiting in nature, such as materials reacting to temperature, humidity, touch, electromagnetic fields by changing their properties such as colour, impacting:
- Electro-/Magnetomechanics: bio-inspired structures as mechanical sensor/actuator when exposed to electrical and/or magnetic fields.
- Metamaterials: overcoming the basic mechanism of achieving a negative index through simultaneously negative permittivity and negative permeability.
- In long term, turn possible artificial Retina using bio-inspired materials and structures as efficient photo-converters in flexible, biocompatible, implantable devices.
- High-density storage devices/spintronics: make use, for instance, of induced chirality in nanostructures to switch between two room-stable configurations, i.e. two logical states.
- Bioelectronic and biophotonic devices and materials for biosensors, both in vivo and in vitro
- Reduce the environmental impact of technologies mentioned above
- Creation of new markets and new business opportunities for the European industry fulfilling or anticipating consumer needs in this area.

Possible horizontal aspects addressed by topic:

- Implemented as cross-KET activities

Activities are expected to focus on Technology Readiness Levels 3 to 5.

The Commission considers that proposals requesting a contribution from the EU between EUR 5 and 8 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

TYPE OF ACTION: Research and Innovation Actions

Title of proposed TOPIC
10 - Sunlight-thirsty Flexible Materials

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Recent trends in photovoltaics (PV) indicate that, in the coming decade, the solar electricity market should have a major component of inexpensive and flexible thin film solar cells aimed at consumer-oriented applications such as building-integrated PV, solar-powered intelligent packaging, portable/disposable electronics, self-sustainable IoT, wearable PV, etc. Therefore, besides cost reduction and improvement of the conversion efficiency, there is now a third challenge driving PV evolution: mechanical flexibility.

The flexural rigidity of a layer scales with the third power of its thickness, so flexibility and cost reduction benefit from lowering the cell thickness; while high efficiency requires effective light management mechanisms, such as photonic structures, to maintain the sunlight absorption while thinning the absorber region. In addition to greatly broadening the range of applicability of PV devices, thickness reduction can bring two other important advantages: 1) for cells not limited by surface recombination, lower thickness can lead to higher open-circuit voltages (and consequently efficiencies) due to lower bulk recombination, and 2) allows manufacturing the solar cells via roll-to-roll industrial processes which can improve the large-scale production of the devices and further reduce their cost.

The specific challenge is the development of photonic-enhanced large-area solar cells on highly-flexible substrates that can reach stabilized efficiencies under mechanical bending comparable to those attained on conventional rigid substrates and superior to 20%.

Scope:

Investigation of the preferential substrate materials and low-temperature solar cell production processes to fabricate thin film PV devices by direct deposition onto flexible substrates.

Development of transfer printing methods to fabricate the solar cells structure on conventional rigid substrates and then transfer it to a flexible substrate, without loss of efficiency.

Design of innovative flexible transparent contacts with high conductivity that allow large-area devices with minimum electrical and optical losses. Development of high-performing and flexible transparent conductive oxides composed of Earth-abundant elements. Investigation of the best materials and geometrical parameters of micro-meshed electrodes.

Development of high-efficient double-junction thin film solar cells. Investigation of 2-terminal and 4-terminal contact configurations. Development of mechanical stacking techniques to fabricate the thin film sub-cells on separate substrates and then attach them together.

Development of optimized flexible photonic structures that allow maximizing the light absorption in thin solar cells, in order to keep their short-circuit current similar to that which can be attained with the corresponding bulk devices.

Development of novel nanostructured PV materials for the solar cells absorber region that allow a better exploitation of the solar spectrum in thin film devices via quantum mechanical effects.

Investigation of architectural designs and technical procedures for the integration of flexible solar modules in buildings. Development of production processes to apply a customized color to flexible modules for improved building aesthetics.

Expected Impact:

Citizens' awareness about the need to foster sustainable and environmental-friendly energy sources has been creating value and encouraging investment in "clean" efficient technologies such as PV power generation.

Innovative approaches combining the areas of applied optics and materials science are those that have been producing the major advancements in PV and are those more likely to strengthen EU role in solar electricity technology. The present challenge requires the combination of the latest advances in the areas of PV and photonics in order to produce low-cost high-efficient mechanically-flexible solar cells. This will motivate the generation of a broad range of novel solar-powered products which will unlock many opportunities for industry, in particular for SMEs.

The development of such devices is particularly important at this time, especially given the European financial crisis. The crisis has been tampering the PV market development particularly in the implementation of large PV power plants, which require important capital expense. Therefore, nowadays it makes more sense the growth of PV in distributed autonomous systems, with non-wafer-based devices which can be supported on a wide variety of rigid (glass, building facades and rooftops, etc.) or flexible (plastics, paper-based, etc.) inexpensive substrates; thereby also extending PV solutions to a wider range of consumer-oriented applications.

Title of proposed TOPIC
11 - Key materials to enable « electronics for everyone everywhere »: low cost, green, safe, flexible

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Enabling electronics for everyone everywhere means providing all categories of citizens with functionalities such as monitoring of their wellbeing, communication, security, … without the need for them to worry about any of the technological issues. This includes devices for sensing, actuation, communication, as well as energy harvesting and storage to power them so they can be autonomous for relatively long periods of time. The electronics for such a goal and all the materials they are made of need to fulfil several, if possible all, of the following requirements: flexible or stretchable, lightweight, wearable and possibly compatible with fashion (Street, Sportswear, Design…), user friendly / non-toxic, washable, recyclable, low cost, autonomously powered. Devices must be high performance and have ultra low power consumption.

Today, technologies are appearing to ensure these functions, but the devices are generally very expensive and not compatible with the uses targeted here. Therefore an entirely new family of low cost flexible and stretchable green electronics is required, which can only be made possible by developing a novel generation of green flexible and/or stretchable materials as basis of new components, interconnections and substrates. These materials need not only outstanding performance but also to be compatible with their full recyclability, especially for a broad range of nomadic, wearable or implantable electronic commodities.

Scope:

The activity should be focused away from solutions such as sputtering routes, targeting mainly low cost processes, compatible with the use of inexpensive flexible or stretchable substrates. The materials to be developed should be free from hazardous chemicals such as lead or indium (to avoid any toxicity issues during fabrication and all along their lifetime including recycling), use very little or ideally no costly chemicals at all such as rare earths (to guarantee the devices will be affordable and reduce dependence towards suppliers that have monopoly on specific substances), they should be highly stable electronically, physically and chemically, and be obtainable by simple/low cost/low temperature mass production fabrication routes. Some strategic targets to be considered are:

- solution-processed n and p-type AOS and hybrid for their integration as proof of concepts in full non-silicon or grapheme based TFTs; CMOS circuits; solar cells or thermoelectric energy harvesters. Solution-processing or other high-throughput methods such as aerotaxy should be used;
- innovative solutions of power management at micro-level
- nano-devices for portable / wearable applications
- tuneable nanostructures including nanowires for novel electronics applications, including the sensing area;
- electrochromic devices with solid-state and polymeric electrolytes for integrated pixel electronics and detection of electrochemical-active bacterias by exploring the electrochromism properties of such materials/devices;
- nano-devices based on nano-assembled structures;
- laboratory lifetime prediction tests and standards to rank materials and surface protection development from early development state.

Expected Impact:

The applications of the materials with the performance described above will have a high impact on key enabling technologies for ICT, which includes novel electronic components, hybrid thin film transistors, logic gates, ring oscillators, bio-sensors/bio-detectors with exceptional properties that can be integrated in small and large area low cost flexible substrates for a plethora of systems integration, in particular wearable or implantable ones.

Title of proposed TOPIC
12 - 2nd and 3rd generation thermoelectric materials and devices

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

In order to solve the complex issue of a global growing population needing a constantly increasing amount of energy, the deployment of renewable sources is mandatory. However, a detailed look at the European global energy flow charts suggests another obvious leverage: Indeed, more than 25% of the total energy resources consumed in EU yearly are actually simply lost and do not serve any purposes. This number increases to more than one third in the case of the world energy flow, according to the Intergovernmental Panel on Climate Change. As a matter of fact, the vast majority of these losses occur as waste heat. If only 0.1% of the yearly European total wasted energy (381 MToe) could be recovered, it would represent an amount of 4.4 TWh/year. Thereby thermoelectricity (TE) that converts thermal gradients into electricity offers a gigantic potential of waste heat recovery. However, 1st generation TE generators (TEGs) are today not efficient enough and far too expensive to be massively deployed. The main reasons for this lack of competitiveness reside mainly in i) the amount (several grams per cm2) of active materials necessary to fabricate TEGs, and ii) the price and toxicity of the state-of-the-art TE materials (e.g. Bi2Te3, Sb2Te3, PbTe, etc…).

Scope:

This Call for proposal would address specifically 2nd (thin film) and 3rd generation (low cost) Thermoelectric materials and devices. The proposals should focus on the development of new low cost processes to deposit and/or print organic or inorganic thin films of highly performing TE materials allowing to design new geometries of efficient TE generators. Furthermore, the projects should tackle the issue of the price of traditional TE materials by identifying, and optimization new materials entirely based on non toxic and non critical elements. Usage of high throughput methods allowing the shortage of discovery, optimization and market entry time is strongly encouraged as well as the involvement of SMEs and other larger industry.

Expected Impact:

- Development of new high performing thermoelectric materials showing properties exploitable in competitive products, and entirely based upon low cost, non toxic and non critical elements;
- Development of new fabrication processes of competitive TE generators to be used in Waste heat recovery systems or to power Internet of Thing Devices;
- Development of standard for TE materials and device characterization;
- Fabrication of TEG prototype showing the technical viability and competitiveness of the devices developed;
- Proven durability of the materials and devices developed within their dedicated environment of use;
- Revive the EU TE industry, vanishingly small, in spite of the world leading scientific excellence of the EU TE community.

Title of proposed TOPIC
13 - Multilayer ceramic environmental shields for very high temperature applications

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Thermal protection systems and thermal barrier coatings are currently used for aerospace applications like thermal shields of space vehicles and coatings of turbine engine hot components. These systems are required to grant oxidation and erosion resistance as well as thermal insulation. Ceramics are frequently used to fabricate them since they are requested to operate at very high temperatures. During the last decades ultra-high temperature ceramics (UHTCs) have been considered and investigated for these applications. Nevertheless UHTCs show some lacks because of their quite high density, the difficulty to perform sintering and the oxidation behavior at intermediate temperatures (between 900° C and 1700° C) where other ceramics like SiC grant better oxidation protection. Actually UHTCs (e.g. ZrB_2) in the above mentioned temperature range give a porous oxide scale which is less effective in delaying the oxidation process than the scale formed on silicon carbide surface. In fact oxidation of SiC results in the formation of a silica surface layer which is not porous and displays a passivating effect. Unfortunately the passive silica layer melts above 1700° C and then evaporates. In addition, this glassy layer can be removed by friction phenomena. For these reasons SiC-UHTCs composites have been also investigated for the application. Environmental protection systems are required to operate at temperatures that are becoming more and more high, because the performance of turbine engines increases with the operating temperature and space and hypersonic flights entail extreme heat flux and temperatures. Multilayer ceramic systems integrating several ceramic layers made of conventional ceramics (like SiC) and UHTCs could allow to face the challenging operating conditions mentioned above. Structure with graded composition (achieved by using composite layers) are expected to minimize the thermal stresses which are mainly responsible for failure of protection systems. Environmental barriers, able to operate in a very wide range of temperature (up to or even above 2000° C), could be designed by alternating layers able to block the oxidation process in different temperature conditions, thus granting a low kinetics of barrier consumption and long lifetime. Suitable methods should be developed for processing these multilayer systems; for instance stacking quite thick ceramic layers processed by tape casting or depositing thin layers by CVD technique could be promising processing routes. This concept of multilayer/multicomponent structure could be adopted also for the surface protection of conventional ceramic matrix composites with continuous fibers (CMCs) or for the development of a new class of CMCs with graded matrices, integrating UHTCs and other components displaying self-healing behavior. In fact the main lack of the CMCs (that are currently used for aerospace applications like nozzles of aircraft turbine engines, rockets and launchers, and are under investigation for the production of hot parts of turbine engines like the liner) is the poor oxidation resistance of their porous matrix made of carbon or silicon carbide.

Scope:

This call is aimed at the development of new concepts of environmental barriers able to grant protection against oxidation for long time in very harsh oxidizing environment and in a very wide range of temperature. This kind of barrier is expected to find application for re-usable thermal protection systems of space vehicles and hypersonic aircraft. In addition these kind of ceramic laminates could also be used for fabrication of hot components of turbine engines owing to their enhanced oxidation and corrosion resistance. The properties needed for the applications mentioned above should be achieved by stacking layers of different compositions made by using silicon carbide, ultra-high temperature ceramics and their composites. Well established industrial technologies, like stacking of ceramic layers processed by tape casting and final sintering or deposition layer by layer through CVD, should be used for processing components or multilayer coatings respectively. These ceramic laminates and coatings should combine layers with different composition able to greatly slow down the oxidation process in different conditions. In fact SiC-based layers proved to undergo passivation at temperature up to 1600°C, while ceramic composites containing UHTCs (e.g. ZrB_2) are recognized to show the best oxidation behavior at temperature exceeding 1700° C. Stacking layers with composition changing progressively passing from a layer to another, and therefore showing compatible thermal expansion, is necessary in order to control the thermal stresses caused by quick temperature variation and make the laminate able to sustain severe thermal shocks. Controlled residual stresses as well as the presence of composite layers will result in enhanced toughness over that characteristic of conventional monolithic ceramics. In fact it is well known that the composite laminates provide toughening mechanisms based on the crack deviation at the interfaces between the different phases present inside a single composite layer and at the interfaces between layers with different composition as well. The same concept and materials combination could be exploited for processing the matrix of CMCs containing continuous SiC or C fibers. The matrix of these composites could be obtained according to the standard processes of repeated infiltration of performs with slurries containing matrix precursor (for SiC) and powders of other ceramics. The slurry composition for each infiltration should be changed with the aim of obtaining a graded composite matrix. Further protection should be granted through the deposition on the CMC surface of multilayer ceramic coating showing composition similar to that of the composite matrix. In addition to aerospace field these kind of oxidation resistant laminates could find applications in the field of solar plants and solar reactors.

Expected Impact:

- Definition of new advanced ceramic composite laminates able to sustain oxidation and corrosion in a very wide temperature range (from room temperature up to more than 2000° C).
- Definition of new advanced composite multilayer environmental barriers (thin coatings) showing enhanced oxidation/corrosion resistance in a very wide temperature range.
- Development of production processes for these laminates able to grant the control the residual stresses arising from thermal shocks (likely occurring both during laminate processing and under operating conditions).
- Development of production processes able to provide laminate architectures showing improved toughness owing to controlled residual stresses resulting in crack deflection at the interfaces.
- Exploitation of the graded multi-component concept for processing new CMCs, with continuous fibers and matrices showing improved oxidation resistance.
- Development of new ceramic structures showing long life under very harsh environments for applications in aerospace (thermal protection systems and propulsion) and solar energy field.
- Providing European aerospace industry of new technologies developed in home for: increasing the re-usability of thermal shields for space applications, increasing the operating temperatures of turbine engines.
- Enabling Europe to compete with other countries (USA, Japan) for the exploitation of UHTCs potential.
- Increase in competitiveness of European industries acting in the field of ceramic and composite materials, space, aeronautics, solar energy.

Title of proposed TOPIC
14 - Bioinspired magnetic microrobots for cancer theranostic

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Cancer is the leading cause of death worldwide in both more and less developed countries. The most concerning part is that the burden is expected to grow worldwide due to the growth and aging of the population, mainly in less developed countries, which accounts for around 82% of the world's population. Changes in lifestyle behaviours such as smoking, poor diet, physical inactivity, and reproductive changes have further increased the cancer burden in less economically developed countries.

Recently the concept of precision medicine has emerged as a promising way to address unmet medical needs. This concept is based on prevention and treatment strategies to take individual variability into account which allow the production of better therapeutic outcomes and simultaneously reducing patient discomfort and undesirable side-effects. Based on the methods developed for precision medicine, the word 'theranostic' was first introduced in 2002 by Funkhouser by coupling the techniques therapy and diagnostic imaging during breast cancer treatment. This method was design to either predict individual drug response or select a patient subpopulation for clinical trials in order to determine a specific therapy such as treatment selection or dose optimization. In this regard the development of theranostic systems may revolutionize the entire healthcare scene by developing personalized medicine to each patient. The use of nanoscale systems is a potential useful tool to achieve the ultimate aim of theranostic: to combine in a single agent both diagnostic and therapeutic capabilities. The latest advances in cancer nanotechnology aims at the design and engineering of targeted contrast agents that improve the resolution of cancer cells to the single cell level, and nano-devices that are capable of addressing the biological and evolutionary diversity of the multiple cancer cells that make up a tumour within an individual.

One of the concepts of precision medicine is the use of minimally invasive techniques to achieve the maximum benefit for the patient, for example, reducing of recovery time, medical complications, infection risks, and postoperative pain to increased quality of care. In this regard, microrobots emerge with the potential to perform tasks that are currently difficult or impossible. The use of micro/nano scale robots that can be externally manipulated opens the possibility to perform a minimally invasive technique for theranostic applications.

One of the most effective ways to control the microrobots mobility inside the human body is through the use of an external magnetic field since it is a fuel-free mobility. Magnetically actuated microrobots are usually inspired by the mobility of natural microorganisms. Among these, helical magnetic microrobots can transform the rotation around their helical axis into a translational corkscrew motion under a low-strength rotating magnetic field. However, the existing methods for producing such microrobots so far are complex and not suitable for large-scale preparation, while the used materials are not biocompatible.

The specific challenge is the development of bioinspired magnetic microrobots for cancer theranostic that are composed of biocompatible and biodegradable materials, prepared by reproducible and easily scaled-up methods.

A promising method for the production of such microrobots is electrospinning that, by careful selection of the most appropriate polymeric materials, allow the production of helical structures with magnetic nanoparticles incorporated. The combination of this simple and easy-to-use technique with biocompatible and biodegradable materials is the basis for obtaining bioinspired magnetic microrobots.

Scope:

The aim of this call is to develop innovative bioinspired magnetic microrobots for cancer theranostic application, produced by exploiting the latest advances in nanomaterials and nanotechnology. The most important issue is to achieve a compromise between the “bio” features of the microrobot (biomimetic, biodegradable, biocompatible) and the magnetic propulsion that is the locomotion base for an effective targeted theranostic system. It is known that the human body is practically “transparent” to magnetic fields, meaning that the magnetic permeability of body is approximately the same as that of an air vacuum. Consequently, quasi-static and low-frequency magnetic fields can be used to apply forces and torques directly to magnetic materials, such as magnetic nanoparticles. Based on this, the desired microrobot must be designed to understand the magnetic’ requirements of the microrobots to achieve an effective locomotion inside the human body.

After reaching a compromise between the “bio” and “magnetic” features of the microrobot, in vitro and in vivo applications can be tested. Magnetic resonance imaging (MRI) is an obvious application due to the natural characteristic of magnetic nanoparticles to improve the contrast of MRI. Moreover, this technique allows the visualization of the microrobots course inside the human body.

On the other hand, targeted drug delivery can be achieved by magnetic guidance of the microrobot to the desired site. This application decreases the incidence of undesired side-effects, allowing a dose reduction and an improvement in the patients’ quality of life post-treatment.

Another treatment application that can be performed with such micro-device is magnetic hyperthermia. This technique is based on locating magnetic nanoparticles into the desired site and to apply an external alternating magnetic field in such a way to cause heat generation by the magnetic nanoparticles. Microrobots meet all the requirements for such application, since they can locate the attached magnetic nanoparticles into the tumour site for specific application of the generated heat, thus sensitizing the tumoral cells for the chemotherapeutic drug.

Proposal activities should lead to high reproducibility and quality on lab scale of cost-effective manufacturing processes that can be easily translated to industrial scale.

The produced magnetic microrobots should be designed for cancer theranostic application, but could be further exploited in other areas.

In order to ensure industrial relevance and impact of the research efforts, active participation of industrial partners represents an added value to the proposals and this will be reflected in the evaluation.

Expected Impact:

- Design of new advanced materials for cancer theranostic with specific and innovative nano/micro-scale properties.
- Development of a biomimetic magnetic microrobot for application in cancer theranostic.
- Development of a magnetic microrobot composed of biocompatible and biodegradable materials.
- Development of a bioinspired microrobot with helical shape and magnetic nanoparticles incorporated to be directed by the application of quasi-static and low-frequency external magnetic fields.
- Face the unmet need of combining precision medicine with minimally invasive techniques in cancer treatment and monitoring.
- Exploitation of highly innovative technologies for new applications in biomedical field.
- Enabling Europe to compete at the forefront of microrobots development also minimizing waste and the use of resources (eco-sustainability) by using biodegradable materials.
- Increase in competitiveness of the biomaterials and biomedical industries in the EU and open new markets.
- Promoting safe-by-design approaches in collaboration with the EU nano-safety cluster.
- Collaboration with the Authorities operating in Healthcare in the definition of the regulatory perspective for this new class of products.

Title of proposed TOPIC
15 - Inter Regional Smart Pilot Lines

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Today Europe is challenged by continuous development of a set of commodities to serve the comfort and needs of end-users. The time line of development processes and products ready to market has been shortening year after year and more and more we need flexibility in how systems and products are tested and validated. For all materials are needed and exploited to the extreme their potentialities, not only as far as properties are concerned but also on the sectors, which they can be used. Therefore more and more multifunctional smart materials and products derived from them are strategic for the future of industry whose centre of gravity is more and more drift towards SME to serve as tester of the market prior heavy investment are made, allowing their re-evaluation based on the market impact and expectations, product costs, sectors of applications to be served and environmental and human impacts.

These needs goes beyond regional smart specialization clusters and should serve inter-regional interests, concerning identified common goals on market needs and specifications of strategic product/systems/materials to be developed. By doing so, the number of expected end-users and potential “money makers” and “creators of jobs” are enlarged, leading so to the Renaissance of new industrial era whose key players are SME.

To promote so, SME need to have available high flexible tools able to backup their developments and tailor market expectations at short/medium term, opened to a plethora of applications. This means that a new paradigm concerning pilot lines should be promoted, away from the existing ones, full adapted to this new strategy, sharing the creativity that exists in the Universities and at RTO, with industry needs and market expectations, bridging in a continuous manner, preventing that novel ideas and innovative results to fail, besides promoting the follow-up of project results towards market. Also human impacts of products developed should be evaluated prior expected products industrialization.

Through this initiative the different European Regions have a unique opportunity to direct also their local funds, expertise and knowhow to actions that may create the maximum of economic and development impact.

The outcome of this activity should promote within EU Regions the prospects for creating linked Hubs of Smart Science and Technology (up to a maximum of 4) based in multifunctional smart pilot lines able to serve multi-sectors (e.g.: energy, electronics, health/biotechnology, manufacturing, security) that must be interconnected via a common governance platform.

Scope:

The proposed pilot lines should address the development, upscaling and demonstration in relevant strategic multisectorial fields involving more than two areas selected from, e.g.: Energy, Electronics, Health, Security, Transport, Food, Manufacturing, among others, exploiting smart materials to be integrated in products/systems with multifunctionalities.

They should use existing innovation concepts in the area of advanced functional materials (organic, inorganic and hybrid) as a starting point for development, incorporating new functionalities and methods to achieve specific application products, with real time analysis and monitoring at the nanoscale to characterise relevant materials properties;

The aim is to increase the level of robustness, repeatability and reliability of such products; to optimise and evaluate the increased performances of the production lines in terms of productivity and cost-effectiveness; and finally to assess the functionality and performance of the new materials/products.

Proposals should address the complete research-development-innovation value chain and able to remove obstacles remaining for industrial application, and involve a number of relevant materials producers and users, where the role of SME should be emphasised.

Technology transfer should be prepared through technology services at affordable costs, facilitating the collaborating with EU SME and large industries, and the rapid deployment and commercialisation of the new technology.

Examples of possible developments include:

- Upgrade existing production methods, extending current capabilities of products able to be exploited in multisectorial fields, including low cost additive nanotechnology methods.
- Enhancing key properties of promising lab scale advanced multifunctional materials away from silicon and upscale their production up to pilot level.
- Applying such products (materials and their integration in self-sustainable systems in more than one sector where they may have strong social and economic impact.

Expected Impact:

The action is expected to lead to a direct economic impact on the industry economy, special to SME as well as society, resulting from issues such as multi-use of the same material serving different fields with increased performance at a low cost due to production cost savings. Moreover, it is expected that the impact should be presented at three levels:

1. Materials producers and users, and other involved industries, demonstrated in the form of reduced costs and full consideration of environmental and safety legislation.
2. Product manufacturers, describing the expected impact from further integration of the nano-enabled multifunctional smart materials into practical large-scale applications with producers outside the consortium,
3. Global impact in form of direct or derived benefits from competitive advantage of the new smart materials and products.

The impact will also be improved by a contribution to training and knowledge dissemination for building an educated workforce.

Overall the action is expected to help driving the demand in Europe as well as support the penetration of new markets worldwide. This should include clear benefits to manufacturers, including SMEs, and new entrants into the market may be expected.

Non-technological aspects key for the marketing of such products (e.g. human societal impacts, standardization, regulatory issues, user acceptance, HSE aspects, LCA) need to be considered.

Activities are expected to focus on Technology Readiness Levels 3 to 5, and target Technology Readiness Level 6. This topic addresses cross-KET activities.

The Commission considers that proposals requesting a contribution from the EU between EUR 5 and 8 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Type of Action: Innovation action/ Pilot lines

Title of proposed TOPIC
16 - Multi-components organic-organic nano-composites for functional and structural applications

Challenge, Scope and Impact of proposed TOPIC

Specific Challenge:

Polymer matrix composites with carbonaceous nano-reinforcement have been proposed for both functional and structural applications. In particular composites containing carbon nanotubes display thermal and electric conductivity, piezoelectric behavior and improved specific strength and stiffness. More recently composites containing graphene-like platelets have been investigated as well and this kind of dispersed phase proved its effectiveness for improving conductivity and mechanical features. Carbon nanotubes (CNTs) still remain quite expensive materials, while graphene platelets (GNPs) in principle can be processed starting from graphite with lower production cost. In order to develop cheap polymer based nanocomposites, which is required for some industrial applications (e.g. in the automotive field), hybrid composites designed by partially replacing CNTs with GNPs could be developed. Finally conductivity as well as piezoelectricity can be locally achieved even when the content of dispersed carbonaceous phases is very low by functionalizing the nanocomposites by laser treatments. This functionalization offers the chance to produce "in situ" electric circuits and devices without using metal wires. These circuits could be integrated in the polymer base components keeping the final weight very low with the aim of reducing the vehicle fuel consumption and, as a consequence, the CO2 emissions. Such a kind of functionalized material shows potential for applications in the field of automotive and, more in general, of transport.

Scope:

This call is aimed at the development of new kinds of polymer matrix nano-composites with low density and a peculiar combination of mechanical and electric properties. These materials should be processed by dispersing both CNTs and graphine-like nanoplatelets in polymeric matrices (that can be co-polymers thermoplastic or thermosets). The content of nanotubes should be kept as little as possible in order to limit the material cost. The addition of proper amounts of CNTs and GNPs would allow to obtain a composite with improved specific strength and stiffness with respect to the unreinforced matrix. Mechanical properties will be tuned for the industrial exploitation of this class of composites in the fabrication of semi-structural components. The addition of the dispersed phases should lead to the obtainment of a not conductive material, being the concentration of the carbonaceous filler below the threshold for electric conductivity. Such a kind of material will be functionalized by using surface laser treatment with the purpose to obtain conductive tracks through the melting and/or pyrolysis of the matrix. Suitable laser treatments conducted locally on the material surface are expected to cause also piezoelectric behavior, thus allowing to obtain "in situ" processed switches. The final scope of laser functionalization deals with the production of completely organic electric circuits and devises, without the use of conductive metal wires. In this manner these electric devices will be integrated in a very light polymer-base semi-structural or structural component.

Biopolymers should be considered as composite matrices in order to develop an environmental friendly product.

The dispersion process will be developed by adopting different strategies like preliminary processing of master batches containing CNTs and/or GNPs. Dispersion methods suitable for providing partial exfoliation of graphite end resulting in a very cheap composite containing graphene-like platelets should be investigated. The effect of the shape and the aspect ratio of the second phases as well as the possible synergic effect arising from the contemporaneous dispersion of tubes and platelets of different size should be investigated by both modeling and experimental tests. Recycling paths for the re-use of production scraps and end-of-life components integrating wireless electric circuits should be developed. Life cycle analysis of this kind of materials should be performed.

Expected Impact:

- Development of new hybrid organic-organic nano-composites displaying both functional and structural characteristics.
- Development of a method for processing through laser functionalization wireless electric circuits integrated in nano-composites.
- Development of a methods for obtaining master batches of polymer/graphene-like nanoplatelets by dispersing graphite in the polymer and exfoliating it in a single process.
- Developing eco-sustainable and recyclable new materials.
- Increase in competitiveness of the nanotechnology industries in the EU and open new markets.
- Providing processes suitable for producing cheap and very light multifunctional components for transport application.
- Matching the EU regulations dealing with CO2 vehicle emissions through reduction of car weight.
- Exploitation of highly innovative technologies for new applications in automotive field and fulfil the EC regulations about recycling of end-of –life vehicles.
- Enabling automotive Europe to compete at the forefront of the nano-tech revolution also minimizing waste and the use of resources.

Title of proposed TOPIC
17 - Smart cost-effective HVAC system integration with high-performance materials for a healthy and safe indoor environment

Challenge, Scope and Impact of proposed TOPIC

Develop an innovative and well-designed materials and system solutions that will reduce the concentration of different pollutants in the indoor air

Specific Challenge:

The need to improve air quality in European countries has been identified as a major requirement to be achieved within the next decade in the effort to control climate change, a key Europe 2020 strategy, and to improve human health.

To integrate a new generation of materials with a smart HVAC system using valid sustainable technologies explored so far as photocatalysis and phototocatalytic paints and coatings that lead to:

- Development of a multi-stage microbial filtration unit: integrating new or proven air purification technologies for particles, bio-particles and hazardous gaseous vapors. Filtration stages should be configured in series or parallel with the new air purification platform.
- Development of a filter regeneration unit that can restore the initial filter capacity, at least partly, upon trigger from a microprocessor. A special focus should be on the regeneration of activated carbon filters. To this end several regeneration concepts and related materials may be considered.
- Development of a system decontamination unit. Filtration of hazardous airborne substances, including volatile chemicals and live B agents, create the issue of safe filter exchange and safe prolonged operation. Biofilm formation on the filters can lead to the re-entrainment of hazardous biological particles into the air stream, and chemical vapors may eventually be desorbed
- Development of a diffusion system coated with a sorbent which may be made by a special form of activated carbon or any other adsorbent material.
- Apply novel doped binary ternary and quaternary semiconducting powders to demonstrate the photo catalytic degradation of a wide range of organic compounds under UV/Vis light irradiation. Among others, inactivation of Escherichia Coli, Klebsiella Pneumoniae and Coliphage must be shown. The photo catalytic activity may also be evaluated for the degradation of inorganic pollutants such as NOx under UV and visible light (defused day-light or artificial indoor lighting) sources.
- Demonstrate clear advantages versus current disinfection techniques: chemical based, filtration or radiation based (e.g. chlorination, ozonation, UV irradiation, etc.).

These technology combinations should be proven to reduce the amount of air pollutants. The concept of this project is to demonstrate the use of HVAC and novel materials (photocatalytic paints and coating) to improving the indoor environments.

Scope:

Buildings energy consumption in the EU is huge and existing problem and relates to heating/cooling technologies that lack sufficient integration of new advanced efficient systems. Potential proposals should address two types of buildings: residential buildings and district heating/ cooling connected buildings. For both types, the integration of new reliable systems should be based on new or existing reliable design tools which would facilitate taking the decision on the installation of the best solutions. The research activities should at least address the following areas:

- Integration of advanced HVAC technologies with hybrid systems combining and integrating novel materials and techniques

- Modelling that would exploit energy waste heat/cool sources.
- Easy installation and integration of such equipment with concern to minimise the maintenance needed and to simplify the logistic.
- Control, safety and monitoring of the entire system, to ensure an efficient match between material functionalization and system supply / demand of energy.

Proposals should provide detailed information on the performance, safety, air-quality improvement and energy data of the buildings. The energy use should achieve at least the national limit values for new buildings according to the applicable legislation based on the Energy Performance of Buildings Directive.

Possible horizontal aspects addressed:

- Suitable for SMEs

For this topic, proposals should include an outline of the initial exploitation and business scenarios, which will be developed further in the proposed project.

Expected Impact:

For residential, commercial and public buildings:

- Demonstration of the economic viability of the overall HVAC and air-cleaning systems when operating in real conditions in residential buildings with a return of investment period of 9-10 years and proof of the potential for market penetration
- Technologies which are reliable and ensure a minimum of 20 years life time
- Solutions compatible with existing building configurations – with compact systems requiring limited operation spaces and retrofit efforts in existing buildings.
- Demonstration of an overall net energy reduction by 20% along with total disinfecting performance for air and microbial substances

For the corresponding materials:

- Scientific and technological breakthroughs in the development of novel concepts in photocatalytic materials design for paint companies
- The activity of the materials is expected be higher than commercial photocatalytic materials, improving process efficiency providing economic and environmental benefits. Evaluation of the Life Cycle Assessment
- New and improved photocatalytic paints based in project results is expected to be in the medium to long term