European Innovation Partnership on Raw Materials

Application for a Raw Materials Commitment

Sustainable substitution in extreme conditions

Acronym:
SUBST-EXTREME
Links to the Strategic Implementation Plan:

- I. Technology Pillar
  - I.C Priority Area: Substitution of raw materials
    - Action area n° I.8: Materials under extreme conditions
      - 1) Substitution of CRM in heat resistant super alloys
      - 2) Substitution of CRM in hard materials

Objectives of the commitment:

The objective of RMC is to create efficient platform for actors from private, public and non-governmental sectors including academia. A large number of commitments cover the entire raw material value chain carrying out actions according to the objectives of the EIP SIP, namely to boost the innovation capacity of the EU raw materials-related sectors. Individual projects alone or research institutes cannot fulfil these objectives. In RMC the partners jointly commit to co-operate and take actions enabling the full potential of primary and secondary materials.Technological objective is to substitute or reduce raw materials that are crucial for a strong European industrial base. In this commitment especially energy, aerospace and mining industries are identified industry areas were scarce elements are widely used in materials.

Description of the activities:

The Consortium will identify and develop substitutes for CRMs in energy, aerospace and mining industries. Materials used in these industries at this moment are heat resistant alloys, stainless steels and hard materials. The whole value chain is present in this RMC, covering research/development, manufacturing and end-users.
The main approach is to increase the use of suitable methods and tools for substitution research and development applied to industrial applications, such as combinatorial approaches to materials research – the consortium are aiming to develop a combinatorial workflow for systematic and efficient materials screening and development, modelling approaches and assessments such as LCA. The second approach is to combine the value chain of the actors in the raw material substitution under extreme condition, the discussion between academia and industry will be beneficial, and the added value of the networking will be boosted. Advanced development of substitutes and developing

substitutes from waste can be route to develop new materials for wear applications. Activities can be divided into two main work packages firstly (work package 1) substituting or reducing the use of scarce elements in stainless steel and heat resistant superalloys used for high-performance structural elements for aerospace and energy industries and secondly (work package 2) substituting or reducing scarce elements in hard materials used for cutting tools, wear parts or in mining applications.
Work package 1: Sustainable substitution of CRMs in metal alloys (WP leader University of Burgos, Spain)
For the stainless steel and heat resistant alloys activities are targeting reduced levels of CRMs through metallurgical development including combinatorial synthesis of new alloys and demonstrate new and emerging alloys or at high temperatures thermal barrier coatings.
Work package 2: Sustainable substitution of CRMs in hard materials (WP leader VTT Technical Research Centre of Finland, Finland, task leaders Uppsala University, Sweden and University of Oulu, Finland)
Hard materials used in cutting tools and wear parts contain scarce elements such as W, Co, Ta and Nb, also less amount Cr, V and Ru. In hard materials substitutes for CRMs are developed with the value chain aspects highly evaluated, starting from manufacturing, involving verification of end users and considering recycling. The toxicity aspect of Co used as binder in hardmetals is identified and its necessity to be substituted is high. It also is expected that even new materials (such as geopolymer composites) can be developed and be substitutes for present hard materials especially in wear resistant applications. The utilisation of ash in geopolymer materials and composites and products can offer a sustainable solution. Another low energy route is direct reduction of suitable waste materials into metallic matrix composites.

Description of the expected impacts:

In this RMC the partners jointly commit to co-operate and take actions enabling the full potential of primary and secondary raw materials in order to find the best solutions for primary CRM substitution. Through this platform intensive networking is possible which helps to mobilise a substantial part of European raw materials community. This Consortium enables multitechnological and systematic approach to materials research, and further helps to develop efficient tools and methods for substitution research.

The readiness level for new heat resistant alloys containing reduced levels of CRM’s is expected to reach TRL4-6, where new alloys may be proved technically feasible and where emerging solutions can be demonstrated at a component or system level. The development of new thermal barrier coatings, to enable the use of lower performing alloys in higher temperature environments, is expected to reach TRL3-4, where technologies can be proved feasible and enable further development and investment.
REACH has classified Co as very toxic for human health. Also, the U.S. National Toxicology program, NTP, states that the tungsten carbide-cobalt hard metal dust has been shown to be toxic. Furthermore, Europe’s hard metal industry is vulnerable due to the dominance of China who holds 85% of the W mines in the world. The Ammonium Para Tungstanate prices have doubled five times in the past 5 years. The proposed substitutions will 1) lead to less toxic substances in the environment which can affect the human health in particular and the environment in general. 2) Increase the competitiveness for Europe´s industry. The TRL as well as the number of WC/Co substitutes is estimated to increase to tolerated level in near future, including increasing the degree of sustainability.

Expected innovation outcomes:
New products to the market

New processes
New technologies
New ideas to the market

Comments:

Finding substitutes or reducing scarce element utilization in these industrial areas will have positive impacts in European level. Work package 1 will focus on industry within aerospace, turbine manufacturing, power industries, oil and gas industries will benefit the substituting solutions and will be more competitive through less dependence of CRMs. Work package 2 will focus on tooling and rock drilling industry, mining industry and wear part industry, having ultimate target on reducing wear with sustainable solutions. The commitment and the project will cover the players covering the material value chain, the concrete outcome will be new products to the market (industry), new processes and new technologies (development institutes and academia, implementation industry) and new ideas to the market (all including end-users).
OTHER: Financinal contribution (in partner profile) consists on existing contribution (national and EU) and expected EU contribution.

Name of the coordinating organisation:
VTT Technical Reseach Centre of Finland
Country:
Finland
Entity profile:
Governmental/public body
Role within the commitment:

Coordination of EIP. Sustainable material desing and modeling, ecodesign, powder technology expertise and facilities, powder production, consolidation and coating facilities. Material performance testing and characterisation, wear, friction, corrosion, tribocorrosion, fatique.

Other partners:

Name of partner:
Pramet Tools s.r.o.
Country:
Czech Republic
Entity profile:
Private sector - large company
Role within the commitment:
industrial plant, experimental development

Name of partner:
Technical University of Liberec
Country:
Czech Republic
Entity profile:
Academia
Role within the commitment:
research institution

Name of partner:
Institute of Chemical Technology, Prague
Country:
Czech Republic
Entity profile:
Academia
Role within the commitment:
research institution

Name of partner:
Millidyne Oy
Country:
Finland
Entity profile:
Private sector - SME
Role within the commitment:
Coating material manufacturer and developer for thermal spraying (agglomerating/sintering/classifying/sieving)

Name of partner:
Instytut Metali Niezelaznych (Institute of Non-Ferrous Metals) (IMN)
Country:
Poland
Entity profile:
Governmental/public body
Role within the commitment:
Research partner

Name of partner:
The Institute of Advanced Manufacturing Technology (IOS), Centre for Materials Research and Sintering Technology
Country:
Poland
Entity profile:
Governmental/public body
Role within the commitment:
Research partner

Name of partner:
ENEA, ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT
Country:
Italy
Entity profile:

Governmental/public body

Role within the commitment:

Design and fabrication of multilayered metal-carbide coatings to increase the effective hardness of the coatings by a surface compression state. -Modelling of thermo-mechanical properties. - Fabrication and characterization of oxides dispersion strengthened ferritic steels (ODS) with nanostructured oxides other than rare materials as Y, Ce, etc. to increase creep-strength and, consequently, the operating temperature in power-plants.

Name of partner:

Slovenian National Building and Civil Engineering Institute

Country:

Slovenia

Entity profile:

Governmental/public body

Role within the commitment:

Our interest is to perform: - research activities in order to develop high quality geopolymer products based on fly ash and biomass ashes which are are available as by-products and get insight into the mechanisms of bonding and the influencing parameters (e.g. chemical composition, particle size distribution, degree of vitrification). - transfer of new knowledge to industry, - preparation of guidelines, - on-site demonstrations of use of novel practice and products.

Name of partner:

VITO Vision on Technology

Country:

Belgium

Entity profile:

Other

Other:

Private non-profit Research & Technology Organisation

Role within the commitment:

VITO is developing its laser research activities into an independent SME activity that will process the new substitute materials into components & tools that are industrially viable for working under extreme conditions, thereby bringing the newly developed products in the market. WP 2 Sustainable substation of CRM in hard materials Processing of substituting feedstock powders into wear resistant components by laser metal deposition (LMD). Laser metal deposition enables the additive manufacturing of high strength, wear resistant components as well as the local improvement of wear resistance by means of a deposited surface coating. The possibility to deposit the high value material only in areas subjected to wear makes the manufacturing process inherently efficient in usage of high value materials. A wide variety of metals and metal-ceramic composites can be processed by LMD. The rapid solidification during LMD results in the ability to produce non-equilibrium metastable phases, minimal dissolution between hard ceramic and metallic feedstock, fine grained microstructure with homogeneous distribution of fine strengthening second phases, etc. Moreover the LMD process can use waste material from various origins (like e.g. milling waste) in powder form as feedstock. To ensure a good part quality the presence of contaminants in the feedstock should be well controlled and kept within acceptable limits. During LMD the presence of materials with low vaporization

temperature can lead to spherical gas inclusions and elements like oxygen and nitrogen can lead to embrittlement of the metal. WP 1 Sustainable substitution of CRM in heat resistant metal alloys Idem WP2 but with focus on locally improving corrosion resistance instead of wear resistance.

Name of partner:
Nanoker Research / SME focused on the development of advanced technical ceramics
Country:
Spain
Entity profile:
Private sector - SME
Role within the commitment:
At the present, Tungsten carbide (WC) is a hard material very used in the industry when extreme conditions (high temperature and wear) are present. Its range of applications is huge including cutting tools for the machining sector, drill bits and special tools for mining and tunnelling, extrusion dies for the metal transforming industry and so on. This material (WC) is commonly alloyed with cobalt (Co), acting as a binder, in order to exhibit better workability and final product properties. Tungsten and Cobalt have been identified as critical metals for the European Union. More and more attention has been paid to these metals due to increased Chinese demand for these metals and aggressive Chinese measures to ensure their internal supply. The availability or lack of these elements can have major impacts on energy systems, and significantly increased demand could strain supply. Due to this fact, other materials should be investigated for substitution of these metals in the prior mentioned applications. Ceramic materials are already being used and are a good alternative for some of the abovementioned products. For example, alumina-based ceramics are materials with good properties in extreme environments. On the same hand, alumina is obtained in a cost-effective way by the Bayern method from bauxite, a very common mineral present in the earth´s crust. In contrast to tungsten and cobalt, many deposits of this mineral (bauxite) are present inside the European borders (Ireland, Spain, France, Germany, Italy, Romania), ensuring a regular supply and a lower variability in the raw material price. In the present work package of this commitment, alumina and zirconia-based ceramics will be investigated in order to be used as a substitution of critical metals as hard materials in extreme environments.

Name of partner:
Ghent University - research group COCOON
Country:
Belgium
Entity profile:
Academia
Role within the commitment:
Research partner

Name of partner:
SANDVIK AB
Country:
Sweden
Entity profile:

Private sector - large company
Role within the commitment:
Partner in WP1 and WP2

Name of partner:
Uppsala University
Country:
Sweden
Entity profile:
Academia
Role within the commitment:
Substitution of Co by alternative binders and/or substitution of WC and Co in cemented carbides for Rock Drilling and Metal cutting (Task leader Uppsala University, Sweden) Partner in WP2 Task leader 2.1

Name of partner:
Universitat Politècnica de Catalunya (UPC) / UNIVERSITY
Country:
Spain
Entity profile:
Academia
Role within the commitment:
Partner WP2 task 2.1 Microstructural/Micromechanical characterization of new developed hardmetal grades

Name of partner:
KTH Royal Institute of Technology
Country:
Sweden
Entity profile:
Governmental/public body
Role within the commitment:
Partner in WP 2 task 2.1

Name of partner:
University of Cagliari (UNICA)
Country:
Italy
Entity profile:
Academia
Role within the commitment:
WP 1 - Research and consulting in the fields of mechanical processing for powder metallurgy, mechanical activation of solids, mechanical alloying and mechanochemistry, chemical, electrochemical and mechanochemical synthesis of materials

Name of partner:
TECNALIA RESEARCH & INNOVATION
Country:
Spain
Entity profile:
Governmental/public body
Role within the commitment:
PARTICIPANT IN WP1 & WP2

Name of partner:
Exote Oy
Country:
Finland
Entity profile:
Private sector - SME
Role within the commitment:
Exote Oy is a finnish SME company specialized in R&D and production of customized advanced materials.

Name of partner:
SCIENCE AND TECHNOLOGY PARK - UNIVERSITY OF BURGOS
Country:
Spain
Entity profile:
Academia
Role within the commitment:
Coordinator WP1. Innovation expert. Coordination of H2020 actions within the WP1. Expert in materials under extreme conditions for ENERGY. Additional Assessment on toxicity. Link to regional industrial cluster. Link to National industrial cluster CEIDEN. Link to regional industrial regulations.Link to South America (through IRELAC)

Name of partner:
University of Oulu
Country:
Finland
Entity profile:
Academia
Role within the commitment:
WP2 task leader - To value from waste. The Fibre and particle engineering laboratory will focus its research in this commitment on development of novel materials from industrial wastes. With the knowledge of designing geopolymer concrete materials from local waste resources, it is possible to develop mix designs where wear resistance of the material is maximized (goal of WP1), and on the other hand develop materials that can be used to substitute refractory metals and thermal barrier coatings (goal of WP2).

Name of partner:
BEFESA ALUMINIO, S.L.
Country:
Spain
Entity profile:
Private sector - large company
Role within the commitment:
Befesa is currently the leading European company for recycling aluminium waste and salt slags, and is the only recycling firm that integrates both parts of the aluminium waste recycling process. Befesa will bring to this proposal its expertise in integral recycling and reuse of aluminium-containing waste for producing aluminium alloys and in recycling salt slags, filter dusts, milling residues and other waste produced by the aluminium industry.

Name of partner:
BAM Federal Institute for Materials Research and Testing
Country:
Germany
Entity profile:
Governmental/public body
Role within the commitment:
Tribological characterisation and analysis of wear resistant components (1.8 WP 1. Sustainable substation in hard materials)

Name of partner:
Università Politecnica delle Marche
Country:
Italy
Entity profile:
Academia
Role within the commitment:
WP.1 Sustainable substitution in hard material; WP 3. Substituting with the value from waste

Name of partner:
KU Leuven (Katholieke Universiteit Leuven), Department of Metallurgy and Materials Engineering
Country:
Belgium
Entity profile:
Academia
Role within the commitment:
KU Leuven aims to develop radically new cermets and ceramic composites aiming a complete replacement of WC-Co. WC will be replaced by NbC (or other non-toxic carbides, nitrides or carbonitrides) and Co by an Fe-based alloy or a ceramic binder such as ZrO_2, Al_2O_3 or Si_3N_4. When successful, these composites will be fine-tuned and upscaled towards their specific

application

Name of partner:
Asociación Nacional de Fabricantes de Bienes de Equipo SERCOBE / Spanish National Association of Manufacturers of Capital Goods
Country:
Spain
Entity profile:
Private sector - SME
Role within the commitment:
Business association (engineering industries)

Name of partner:
Delft University of Technology
Country:
Netherlands
Entity profile:
Academia
Role within the commitment:
The next generation of (concentrated-solar) power plants and car engines need to operate at higher temperatures and pressures in order to reach higher energy conversion efficiencies, which is essential for the deployment of low-carbon energy technologies. Today, the preferred materials of choice for these extreme conditions are nickel-based superalloys with high concentrations of Cobalt in order to reach temperatures of 700□C and above in combination with pressures of 320 bars and above. My role within the commitment is to contribute to the substitution of the nickel-based superalloys with high concentrations of Cobalt by steels with improved creep-resistance at higher temperatures.

Name of partner:
Technische Universität Wien (Vienna University of Technology)
Country:
Austria
Entity profile:
Academia
Role within the commitment:
Partner in WP2

Existing EU contribution:
Yes
Source:
FP 7

Period to implement the commitment:
Wednesday, 1 January, 2014 to Monday, 30 December, 2019

le-substitution-extreme-conditions