PROtective composite Coatings via Electrodeposition and Thermal Spraying - PROCETS

HORIZON 2020

The Problem

Wear and corrosion of materials causes losses of 3-4% of GDP in developed countries and billions of Euros are spent annually on capital replacement and control methods for wear and corrosion infrastructure. As a result many important industries are dependent on surface engineering of protective coatings, making it one of the main critical technologies underpinning the competitiveness of EU industry. There are two main techniques that dominate the protective coatings sector: hard chromium (HC) plating and thermal spray (TS). However, HC plating faces a series of issues including negative health and environmental impact leading to the EC restriction of this method for using Cr+6 by the end of 2017. Similarly, recent toxicity studies concerning Co-WC cermet applied by TS have revealed that Co-WC particles are toxic in a dose/time-dependent manner. Consequently, there is the necessity of finding new, less hazardous methods and materials exhibiting the same or better performance compared to existing ones.

PROCETS Overall Objective

PROCETS will optimize a number of scalable methods and properties, in order to provide the next generation of protective coatings. Enabling the shift to more environmental friendly materials with enhanced properties. The objectives are classified in three groups:

Electroplating and Coatings

Optimum mechanical performance combination of hard (e.g. SiC, Al2O3, B4C) and self-lubricant (e.g. BN, nano-graphite) nano-particles to be integrated in a hexavalent chromium free electrolytic bath (e.g. Ni-P, Ni-W-P, trivalent chromium).
Integration of nano-particles in the electrolytic baths and using appropriate mixture of additives and ultrasonication method.
Development of a DC electroplating method in pilot lines for composite coatings with thickness up to 250μm. 3x times faster than conventional hard Chromium / Current efficiency >70%.
To deliver pilot PC plating lines for composite coatings with thickness up to 300μm. Current efficiency >70% / Functional properties +20% compared to DC.

Thermal Spray and Coatings

Develop green carbide powders by efficient mechanical alloying procedure to be used as feedstocks for thermal spraying.
Development of a controlled and reproducible enhanced process based on Thermal Spray to optimize green carbide coatings able to be used to replace WC-Co coatings at industrial level.
Development of coatings produced with the developed green carbides materials having controlled and reproducible features/properties.
To evaluate and fulfil application requirements.

Demonstration and Validation

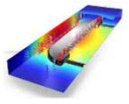
Set up, integrate nano-particles and operate the electroplating pilot lines
Integrate TS in an industrial pilot-line and evaluate the life-in-service of the coated components
Test case Tenneco – rods: Apply protective coatings by electroplating (both DC and PC) methods in rods to be integrated in shock absorbers.
Test case Husqvarna – cutting tools: Apply protective coatings by electroplating (both DC and PC) in cutting edges of chain links to be integrated in chain saws
Test case Chromomed – Laminating roller for steel industry: Apply thermal spray coatings in rollers to be integrated in laminating
Test case Wienerberger – Scrapters and mixer components: Apply thermal spray and electroplating coatings in components of clay manufacturing industry machines

Market replication and exploitation of results

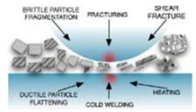
Evaluate, compare and understand the significance of environmental impacts from the technologies of PROCETS project
To verify the compliance with standards of all projects results
Continuously update the initial business plan based on the progress of the project and conducting potential market search.
Protection of the knowledge that will be developed during the project – IPR issues

The Approach

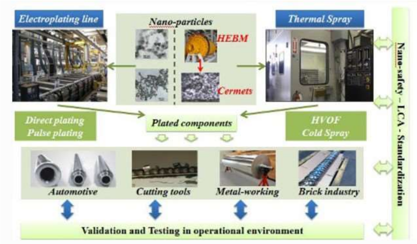
PROCETS main target is to deliver protective coatings covering a wide range of applications such as automotive, aerospace, metal-working, oil and gas and cutting tools industries via thermal spray and electroplating methods by utilizing more environmental friendly materials, compared to the currently used. This will allow the replacement of the hazardous process of hard chromium plating and WC-Co coatings via thermal spray.



Current flow in electroplating of irregular shapes



Mechanomade® HEBM nanostructured material production



Schematic concept of the PROCETS project

Implementation

Pilot line of electroplating:

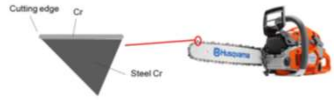
- Nano-particles bath integration optimisation
- Direct Current Plating
- Pulse Current Plating

Pilot line of thermal spraying:

- Production of nano-structured cermets
- Powder Shaping and Screening
- Mechanical alloying
- Application of thermal spray process

Husqvarna use case

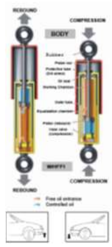
Currently Husqvarna is searching for environmental friendly alternatives to Cr coatings. Environmental and health safety regulations, will ban the hard chromium process which emits hazardous Cr+6. Thus, Husqvarna will provide the electroplating companies with the necessary un-coated cutter links in order to apply the novel PROCETS composite coatings.



Cross-section of a cutting edge with Cr coating on a cutting link

Tenneco use case

Currently piston rods are protected by hard chromium coatings. Tenneco is in search for finding a suitable replacement of hard chromium in order to adopt it to its production lines. The electroplating SME members of the consortium will provide the technological solution.



Tenneco shock absorber use case

Roller after EDT process with a smooth and homogeneous roughness

Cromomed use case

Rollers are the main tool used for laminating in the steel industry. The rollers for laminating must accomplish especially stringent conditions. Their main properties must be: breaking strength, wear resistance, good surface finishing, heat cracking resistance, and scale formation resistance. PROCETS coatings will comply to all the above requirements.

Expected Impacts

- Accelerated market uptake of nanomaterials and products in the surface finishing sector
- Improvement in existing manufacturing processes and equipment through integration of nano-materials, demonstrating better resource efficiency, safety, sustainability and recyclability of a wide variety of components and final products
- Improvement in technical knowledge on the integrated manufacturing processes for nanomaterials in terms of productivity, environmental performance and cost-effectiveness
- Contribution to development of business plans that encourage private sector investment for future business growth
- Promoting safe-by-design approaches in collaboration with the EU nano-safety cluster and contributing towards the framework of EU nanosafety and regulatory strategies

Project Partners

Contact:

Coordinator

Prof Dionysis Bochtis
Institute Director - Coordinator
d.bochtis@certh.gr
+30 2311 257651 | +30 2311 257650

CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

iBO Institute for Bio-economy & Agri-technology

iBO | CERTH
6th km CharilaouThermi Rd.
57001 | Thermi | Thessaloniki | Greece
www.ibo.certh.gr | www.certh.gr