

Invitation to Industry for participation

Discovery of complex quaternary metallic coatings using Combinatorial Synthesis and Screening "CSS"

Project proposal(s) of the Network of Excellence (NoE) Complex Metallic Alloys (CMA)

1	Introduction	2
2	Overview of the objectives	2
3	Innovation potential	3
4	Summary of the main Deliverables	3
5	Participation of industries	4

1 Introduction

Due to the unparalleled diversity of metallic materials, metal-based industries will remain of outstanding importance for the competitiveness of Europe's economy in the 21st century.

Complex Metallic Alloys (CMA), only recently available due to progress in materials science, offer great potential for innovation - which is the key for strengthening and maintaining the competitiveness. Wherever materials need to offer hybrid properties, being both structural and functional, or embody an extraordinary combination of properties that are mutually excluding in conventional materials, CMAs will be the materials of choice. Potential applications exist in thermoelectricity, reduced friction and cold-welding, corrosion resistance, heat insulation at low temperature, enhanced catalytic efficiency at lower cost, optimised composites, nano-structuring of metallic aggregates or coatings, etc.

To make use of the tremendous potential of Complex Metallic Alloys in industry new fast, reliable and cost efficient methods with high throughput capabilities are required. Today of the half a million ternary metallic systems theoretically possible, only a few percent have ever been looked at. There is no information on their physical and chemical properties. This holds even more so for four-component intermetallics.

Building on this requirement the present project proposal "Discovery of complex quaternary metallic coatings using Combinatorial Synthesis and Screening (CSS)" has been designed.

Combinatorial Synthesis and Screening (CSS) are high-efficiency methods to create and analyse large numbers of different CMA compositions with a wide variety of properties to build high value libraries of potential Complex Metallic Alloy materials. Such libraries will contain systematic, specific alloy (CMA) properties obtained through a combinatorial route, in contrast to today's "one-composition-at-a-time" approach.

These libraries contribute to the discovery of new materials and also provide data leading to improve theories and models of materials chemistry and physics. Similar approaches have been successfully applied in fields such as biotechnology or functional inorganic materials using thin film techniques. For the Complex Metallic Alloys combinatorial methods provide a new paradigm for advancing a central scientific goal - the fundamental understanding of processing-structure-property relationships.

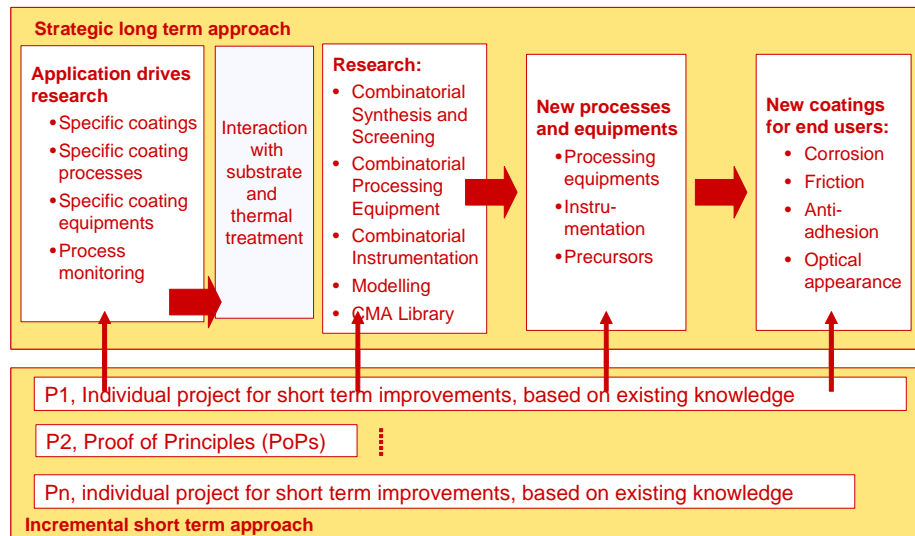
2 Overview of the project

The ultimate objective will be to provide materials with an optimum performance selected from a huge number of possibilities. The proposed Combinatorial Synthesis and Evaluation of CMA coatings will allow a faster, better & cheaper correlation between processing conditions, structures and properties.

The integration of stakeholders from research to market will be allowed by the structured systematic approach along the value chain. Incremental and short term innovation projects will be linked to the long term strategy through the exchange of knowledge and experiences from these projects. The overall approach will allow dividing the set-up into several projects such as:

1. Proof of principles (Pops) to make sure the proposed solution path will not lead us into a bottleneck
2. Short term projects to provide solutions to industry with the existing knowledge.
3. Long term project(s)

The CSS approach is application driven and concentrates on: Corrosion, friction, anti-adhesion, optical appearance and focusses on the mechanical field. As a starting point, the following chemical constituents will be used: Al, Cu, Fe, Mo, Mn or others.



The CSS approach

3 Innovation potential

Intrinsic properties of CMAs promise that these materials can become basic building blocks for future high performance materials for applications such as: Thermoelectrics, Tribology, Corrosion, Wetting, Abrasion, Cold welding, Heat insulation, Catalysis, high temperatures applications, Magnetic properties and Lithium storage.

CMAs have the potential to be the drivers for innovations in the traditional European metal industry. However, the only way to transform the outstanding potentials of Complex Metallic Alloys with their tremendous variety of combinations efficiently to sustainable products is the combinatorial high throughput methodology to synthesize and screen binary, ternary and quaternary metallic alloys.

The key functionality of this approach is its highly-efficient, controlled, combinatorial production, screening and evaluation of coatings composed of complex metallic alloys with variable, clearly defined compositions and properties, and doing this in a fast, reproducible, inexpensive and rational way.

Theories and models do exist for the prediction of properties of complex metallic materials. An important outcome of this project is to feed such theories and models with a large number of experimental data. This will allow:

1. Validation or improvement of these instruments;
2. Their use for the reliable explanation and prediction of metallic material properties in general.

4 Summary of the main Deliverables

1. Discovery of new CMA material systems with specific properties for selected applications
2. Creation of a CMA library for the selection of appropriate CMA systems for a given application
3. A breakthrough in synthesis and screening from the "one-at-a-time" method to the "combinatorial synthesis and screening" will revolutionise the discovery of the complex metallic alloys
4. High throughput synthesis and screening method to evaluate the properties of the binary, ternary and quaternary complex metallic alloy systems and phases
5. Improvement of basic knowledge and theoretical models with the *processing-structure-property* relationship by thousands of experiments within a short time
6. A real step ahead to support the materials by design approach

5 Participation of industries (along the value chain)

1. Specification of future actual and requirements
2. Test of specimens with respect to specific industrial applications
3. Benchmarking with existing solutions
4. Definition of demonstrators

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