European Commission

ACCMET Report Summary

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Periodic Report Summary 2 - ACCMET (Accelerated Metallurgy - the accelerated discovery of alloy formulations using combinatorial principles)

Project Context and Objectives:

The core concept of Accelerated Metallurgy is to deliver an integrated pilot-scale facility for the combinatorial synthesis and testing of many thousands of unexplored alloy formulations. This facility would be the first of its kind in the world and would represent a significant advance for metallurgy. The novel technology that enables this high throughput technology HTT facility is based on automated, direct laser deposition (DLD). The key feature of this technology is the way in which a mixture of elemental powders is accurately and directly fed into the laser's focal point, heated by the laser beam, and deposited on a substrate in the form of a melt pool, which finally solidifies to create a unique fully-dense alloy button with precise stoichiometry.

This robotic alloy synthesis will be 1000 times faster than conventional manual methods. Once produced, these discrete mm-sized samples are submitted to a range of automated, standardised tests that will measure chemical, physical and mechanical properties. The vast amount of information will be recorded in a "Virtual Alloy Library" and coupled with computer codes such as neural network models, in order to extract and map out the key trends linking process, composition, structure and properties. The most promising alloy formulations will be further tested, patented and exploited by the 20 end-users.

Industrial interests include: (i) new lightweight fuel-saving alloys (<4.5 g/cm3) for aerospace and automotive applications; (ii) new higher-temperature alloys (stable>1000 degC) for rockets, gas turbines, jet-engines, nuclear fusion; (iii) new high-Tc superconductor alloys (>30K) that can be wire-drawn for electrical applications; (iv) new high-ZT thermoelectric alloys for converting waste heat directly into electricity; (v) new magnetic and magnetocaloric alloys for motors and refrigeration; and (vi) new phase-change alloys for high-density memory storage.

Project Results:

The first year of Accelerated Metallurgy has focused on employing the appropriate research staff to achieve the stated goals as well as on acquiring the necessary high throughput equipment to perform combinatorial metallurgy. Apart from a couple of positions in specialised technologies, a full complement of staff is now active on the Project consisting of dedicated post-doctorate and post-graduate researchers. For example, a new research group has been assembled at the ESRF and ILL facilities in Grenoble to progress diffraction studies on AccMet and associated European projects.

A detailed assessment of the equipment available to the project revealed the need to purchase a number of additional accessories and, in some cases, complete machines so as to mobilise for rapid alloy synthesis and rapid testing and analysis. Indeed, considerable development has been, and is still being undertaken to convert existing techniques and also produce new techniques to raise the available equipment to a combinatorial standard. This intense activity has reached a state where suitable alloy samples of specific compositions can be synthesised and this process is currently being automated. Likewise, analytical techniques for basic alloy property evaluation will soon be available so that data can be generated to populate the alloy database. Target alloy systems for the initial investigation have been selected by the Project end-users from

which it is intended to reach a minimum level of data on the database from which to extract key trends for future predictions of alloy compositions.

Potential Impact:

The accelerated discovery of alloy formulations will have a very high impact on society through direct exploitation. All industrial partners are actively involved in defining requirements and setting desired property targets which means that the most promising alloy compositions discovered in AccMet will be scaled up, tested and patented by the relevant companies, and will be thus exploited by world-leading end-users. Many of these will contribute to the EU's SET Plan [EC

COM 519, Oct 2009], that aims to industrially develop and deploy low-carbon technologies in Europe by 2020.

The expectation from AccMet is to be able to dramatically shorten alloy development time from the 5-6 years that is typical in many high-tech sectors to less than 1 year. This rapid, optimised approach is estimated to save industrial R&D departments many tens of millions of Euros, which is significant in the light of the difficult economic times. It is anticipated that the combinatorial approach applied to bulk alloys will lead to accelerated innovation and productivity in various industries such as energy, aerospace, automotive, chemical, electrical, computing etc. all of which will broadly benefit our society. Considering the success of HTT in other sectors, notably pharmaceuticals and catalysis, it is fair to say that companies that apply high-throughput methodologies have a significant competitive advantage over their competitors, due to the faster development of their new products.

There will be a special emphasis on finding alloy solutions through sustainable development that is of high strategic value and fits well with a decade of European policy in this area [Göteborg Declaration, 2001; and Europe2020 Strategy, MONAh 2010]. Ideally, the new alloys should have a reduced environmental impact and, where possible, focused on being non-toxic to humans, animals and the environment; abundant thereby lowering the ecological impact of the mining sector; locally-sourced thereby reducing emissions from transport and shipping across the globe; recyclable particularly since energy-saving can be 90% of primary production; durable so that alloy components do not need to be frequently replaced; and amenable to efficient metal processing such as low-waste net-shape additive manufacturing. By taking into account these “eco-properties” at the alloy design stage as well as carrying out life-cycle analysis (LCA) for newly discovered alloys, AccMet will have a positive and lasting effect on sustainable development and will demonstrate global leadership and environmental stewardship.

List of Websites:

http://www.accmet-project.eu/

Contact

Martin ZELL, (Head of ISS Utilisation Dept.)

Subjects

Innovation and Technology Transfer

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