ACCMET Report Summary

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Periodic Report Summary 4 - 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, Additive Manufacture (AM). The key feature of this technology is the way in which a mixture of elements are 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 materials for bio-medical devices.

Project Results:
The fourth year of Accelerated Metallurgy has built on the sound foundation set by the previous years' activities and has met all its stated goals so that it is on course to deliver the major Project Objectives. A range of synthesis techniques are now available to produce prescribed combinatorial samples for targeted alloy development as defined early in the project by the Project end-users. A network of rapid analytical techniques has also been established including unique specially developed equipment to meet the high throughput principles. There has been a concerted effort to benchmark the output from these techniques and procedures are in place to monitor results to ensure that all generated data can be relied upon once it has been uploaded into the purposely commissioned database. Computer models have been built to predict new material compositions and properties from key trends in the data. It is thus possible to practically confirm these predictions by repeatedly making and analysing samples until the models determine accurate compositions that achieve the target portfolio of properties for the end-user application. The major achievement of commissioning the automated combinatorial facility has not only massively increased the rate of production of alloy samples but has also provided the capability of melting all elemental metals so that any alloy can now be made. This has been invaluable in the search for high temperature capable materials and multi-component alloys such as HEAs and BMGs. The suite of new analytical techniques and alloy database is currently being assembled into a single integrated combinatorial facility that will leave a lasting legacy for participants to pursue automated alloy development long into the future.

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.
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/

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