Selective laser sintering of in-situ reinforced aluminum composites

Summary

The PhD position is opened for an Early State Researcher to be involved into additive manufacturing through selective laser sintering of aluminum alloys, which are in-situ reinforced by ceramic phase. Ambitions and expectations of the PhD project are extremely high as the synthetic materials necessitates a precise modulation of composition and structure. For SLM, the interaction between the laser beam and powder material is one of the dominant phenomena defining the feasibility and quality of process. To meet the demands, new adopted materials should be developed with the shape and size tolerances and compositions modified to fit the process. The use of computational thermodynamics can guide in the tailoring of the phases comprising their interfaces and spatial distributions.

Research field:	Production and materials engineering, robotics, transport and logistics
Supervisor:	Prof. Dr. Irina Hussainova
Availability:	This position is available.
Offered by:	School of Engineering Department of Mechanical and Industrial Engineering
Application deadline:	Applications are accepted between October 01, 2022 00:00 and October 23, 2022 23:59 (Europe/Zurich)

Description

The **project aims** at far beyond the state-of-the-art platform for production of the self-reinforced complex structured composites. The **objective** is development of light-weight highly wear resistant structures successfully working in tribo-conditions exploiting bio-replication of architecture and gradients of bone (energy absorption) and surface texturing of snake (low friction and wear).

The **ultimate goal** of the project is twofold: (i) development of materials solutions allowing gradient manufacturing and in-situ reinforcement during AM through Selective Laser Melting/Sintering (SLM\S); and (ii) development of a technological procedure for modulating the local composition and structure for sintering lightweight reliable wear resistant composites.

For SLM, the interaction between the laser beam and powder material is one of the dominant phenomena defining the feasibility and quality of process. To meet the demands, new adopted materials should be developed with the shape and size tolerances and compositions modified to fit the process. The use of computational thermodynamics can guide in the tailoring of the phases comprising their interfaces and spatial distributions. However, defining the optimum material distribution function requires extensive knowledge of material data that includes the chemical composition, its characteristics and manufacturing constraints. Among the Al-based alloys, the most studied is AlSi10Mg. Very few alloys consisting transitional elements to stipulate on in-situ hardening through formation of intermetallic phases are detailed.

Study on AM of an innovative Al-Mg alloy modified with Sc and Zr (Scalmalloy) is at very beginning, but results are promising. Some alloys being under protection are not studied yet. Moreover, AM of ceramic and ceramic-metal composites are far from mature.

Responsibilities and (foreseen) tasks

- To perform research on light-weight aluminum composites to be processed by SLM/S
- To develop/design (with the help of thermodynamic calculations) the materials suitable for SLS
- To model/design (using CAD) the topology/architectures of the samples to be tested
- To collect data and conduct case studies on the selected cases on experimental approaches and institutional innovations
- To characterize the materials (microstructure, composition, mechanical properties)
- To contribute to the organization of research and workshops where project findings are presented

Applicants should fulfil the following requirements:

- a master's degree in Materials Sciences or Materials Engineering (preferably in metals and ceramics; materials chemistry; and powder metallurgy)
- skills and experience in materials microstructural characterization (optical microscopy, SEM, XRD etc) by use of quantitative methods
- a clear interest in the topic of the position
- excellent command of English
- strong and demonstrable writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to provide assistance in organizational tasks relevant to the project

The following experience is beneficial:

- Experimental and/or theoretical chemistry
- Experience/knowledge in powder metallurgy/additive manufacturing
- Working knowledge of thermodynamic calculations
- Working knowledge of CAD
- Scanning electron microscopy, XRD, Raman spectroscopy
- Mechanical testing

We offer:

- 4-year PhD position in one of the largest, most internationalized and only University of Technology in Estonia with a large portfolio of ongoing pan-European and national projects
- The chance to do high-level research in an international team
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers all over the world

About the department

The department of Mechanical and Industrial engineering focuses on the engineering side of self-driving vehicles, developing new coatings and additive manufacturing developments. The curriculums on Bachelor, Masters and Doctor level have hundreds of graduates each year. We also provide engineering services for industry and our partners, starting with modelling and finishing with production optimization.

TalTech houses state-of-the-art powder metallurgy and additive manufacturing laboratories, plus laser, optical, metrology and chemical labs and equipment – the ideal environment for world-class materials development.

Additional information

For further information, please contact Prof Irina Hussainova (Irina.hussainova@taltech.ee) or visit https://taltech.ee/en/department-mechanical-and-industrial-engineering

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