Development of Fe-based hardfacings with in-situ synthesized single and mixed carbide reinforcement

Summary

The proposed PhD thesis focuses on the development of welded and thermally sprayed composite overlays with a Fe-based matrix, reinforced by in-situ synthesized single and/or mixed carbides, thought for various room and high-temperature wear conditions. The work assumes both theoretical (phase modelling, etc.), as well as practical (wear testing, etc.) tasks.

Research field:	Mechanical Engineering
Supervisors:	Dr. Kristjan Juhani Dr. Andrei Surženkov
Availability:	This position is available.
Offered by:	School of Engineering Department of Mechanical and Industrial Engineering
Application deadline:	Applications are accepted between November 15, 2021 00:00 and December 15, 2021 23:59 (Europe/Zurich)

Description

Fe-based alloys as binders in metal matrix composites (MMCs) attracted much attention in recent years due to their relatively low cost and high strength, as well as toxicity and scarce resources of the conventional binders, like Ni or Co. However, the low wettability of the ceramic reinforcement by a Fe-based melt, as well as the high chemical aggressiveness of the latter restrict a wider usage of Fe-based binders.

One solution could be the in-situ synthesis of ceramic reinforcement. Apart from the absence of the above-mentioned issues, the latter has other advantages, like a higher thermodynamical stability, a stronger cohesion with the binder, and a smaller average size to be compared with the ex-situ added reinforcement. On the other hand, not all ceramic phases may be in-situ synthesized in a Fe-based alloy, and the reinforcement distribution may be non-homogeneous, as well. This PhD thesis will focus on finding feasible solutions to these problems. The main aim is to develop Fe-based surface MMCs, reinforced with the in-situ synthesized single (TiC, etc.) and mixed (TiC-(Fe,Cr)7C3, etc.) carbides, which are deposited by plasma transferred arc welding and high velocity oxy-fuel spraying. The end target is to obtain surface MMCs with tailored room and high-temperature anti-wear properties. The tasks of the PhD student will include, but not be limited to:

- modelling of phase transformations;
- preparation of precursor powder mixtures,
- conducting wear tests, etc.

During the studies, the PhD student must co-author at least three scientific papers on the topic of the doctoral thesis, whereas two of which must be publised in Q1 and/or Q2 (SCImago) journals. The PhD student is also expected to spend at least one semester at a research centre outside Estonia (through Erasmus+ or another program) during his/her study. Apart from that, the PhD student should be ready to supervise bachelor and/or master student(s), as well as to take part in other teaching activities.

Applicants should fulfil the following requirements:

A suitable PhD candidate has a MSc. or an analogous degree in mechanical or chemical engineering, and has a deep understanding, how microstructure features like grain size, etc., and phase composition of a material affect its properties. (S)he is competent in phase diagrams, and can describe the microstructure formation on their base

(knowledge of ThermoCalc® is a plus). A PhD candidate should have at least general knowledge of welding and/or thermal spraying, as well as of powder metallurgy, especially of the cermet manufacturing. A PhD candidate is expected to be ready to solve as theoretical, as practical tasks, and to analyze the results. (S)he should have a good command of English, and be able to work both in a team, as well as independently.

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