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DocMASE Project Proposal DAAD-2018-2

Project Title	**Microstructural design for performance tailoring in high chromium cast irons**
Main University and Advisor	Saarland University, Prof. Dr. Frank Mücklich (Chair of Functional Materials)
Associated Partner(s) (if applicable)	Dr. Joan Josep Roa (Barcelona Tech), Prof. Dr. Carsten Gachot (Technical University of Vienna, Research Center AC²T)
Project Description (with **image**, if applicable)	High-chromium white cast irons (HCCI) containing 12–30 wt.% Cr and 2-3.5 wt.% C are extensively used for abrasion-resistant applications such as components that manipulate and mechanically process aggregates and raw materials. Their wear resistance and mechanical properties depend on the type, morphology and distribution of carbides, and on the nature of the supporting matrix structure which, in turn, depends on the chemical composition and on any subsequent thermal treatments (TT). The types of secondary carbides formed during the destabilization depend on the composition and destabilization temperature[1–3]. The current trend is to expand the uses and duty life of HCCI by exploring alternative TT that would affect the type and nature of precipitates. However, the relationship of microstructure, hardness and corrosion resistance of HCCI with different matrices has not been systematically addressed. In order to understand the new configuration in these materials, the new microstructures (both, the matrix and precipitates) must be thoroughly studied and correlated to the improved physical properties. A new approach with the development of HCCI must be based in tailoring the microstructure in order to obtain the desired performance of the material for a specific application. The basis for this is to find the best matrix/precipitates combination based on the nature, size and distribution of secondary carbides, which can be controlled by adjusting the temperature and annealing time at the destabilization and/or sub-critical diffusion (SCD) steps [2,4]. In this work, we will evaluate the influence of the temperature and annealing time during a multi-step TT, which includes a destabilization of the austenitic matrix at high temperature, a SCD and a final quenching step to obtain a final microstructure composed by eutectic and secondary carbides embedded in a martensitic matrix. Highly important is the assessment at the micro and nano scale of the different type of carbides precipitated during the multi-step TT and how their size and distribution affect the mechanical properties (such as abrasive wear and hardness). Moreover, we intend to evaluate how the matrix/carbide interaction and the chemical distribution near the carbides have an effect in the wear properties. The goal of this project is the design of a set of thermal treatments with the focus in the control of the microstructure and hardness in HCCI (2.5 %C - 26 %Cr) with the aim of customizing the material for an especial application. The material characterization will include advance characterization techniques (SEM/FIB, TEM, EBSD, APT, micro/nano-indentation, tribological tests, etc.) and microstructural and strengthening modelling.
References	[1] Kopyci D. et al., Archives of foundry engineering 14 (2014) 43–46. [2] Wiengmoon A. et al., Mater. Chem. Phys. 125 (2011) 739–748. [3] Carpenter S.D. et al., Mat Chem Phys 85 (2004) 32–4085. [4] Carpenter S.D et al., Materials Chemistry and Physics 101 (2007) 49–55.
Requirements of the candidates / Requirements during the doctoral programme (courses, seminars, etc.)	Very good English command. Bachelor in Materials Science, Chemistry, Physics or related disciplines. Master in Materials Science or related disciplines. Experience in the thematic field and German knowledge will be appreciated but not compulsory. The general requirements for the DocMASE program regarding courses, seminars, summer schools, etc must be fulfilled. Particulraly, 30 ECTS of lectures have to be validated at the end of the PhD and you are expected to publish the results of your studies in international peer-reviewed journals.