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DocMASE Project Proposal DAAD-2016-1

Project Title	***Process design and advanced microstructure characterization of high performance bainitic based steel***
Main University and Advisor	Saarland University, Prof. Dr. Frank Mücklich (Chair of Functional Materials)
Associated Partner(s) (if applicable)	TU Bergakademie Freiberg, Institut für Metallformung, Prof. U. Prahl COMTES FHT a.s., Czech Republic, Dr. Pavel Konopík
Project Description (with **image**, if applicable)	Processes related to phase transformations are a potential set of procedures for tailoring the microstructure and performance of alloys. The particular material phase transformations, which take place during thermomechanical processes, have technological importance for industry and its successful rely on understanding and correct application of key mechanisms that control microstructure and thus material properties. In this regard, the extension of the microalloyed high strength low alloy (HSLA) steels use for transmission pipeline applied in harsh environment (e.g. permafrost and seismic grounds) requires combination of conflicting properties such as strength and ductility. Furthermore, additional considerations like low Carbon and low Silicon, for suitable weldability of this class of steels, set an upper bound limit for employing these elements to promote steel properties enhancement through Quenching & Partitioning (Q&P) concept [1,2]. Thus, processes for promoting TRIP-aided, where transformation plasticity leads to expressive improvement in the properties due to the presence metastable Austenite, must consider these boundary conditions. On the other hand, relatively high strength can be achieved by making use of bainitic microstructures. Nevertheless, by design innovative process exploring the Bainite incomplete reaction (ICT) [3] and Carbides dissolution [4] phenomenon, it is likely that the multiphase bainitic microstructure with metastable Austenite may result in the expected properties. These inputs have shown opportunities to better understand the Physical Metallurgy comprising strengthening and ductility limits of HSLA steels. Thus, this project is focus on iterative approach combining a systematic alloy-process design, getting best scientific descriptions of thermo-kinetic computational methods, driven by high-resolution material characterization in different length scales, aiming to understand the competing processes for Austenite stabilization in fairly lean alloy steel.
References	[1] J. Speer, D.K. Matlock, B.C. De Cooman, J.G. Schroth, Carbon partitioning into austenite after martensite transformation, Acta Mater. 51 (2003) 2611–2622. https://doi.org/10.1016/S1359-6454(03)00059-4. [2] M.J. Santofimia, L. Zhao, R. Petrov, J. Sietsma, Characterization of the microstructure obtained by the quenching and partitioning process in a low-carbon steel, Mater. Charact. 59 (2008) 1758–1764. https://doi.org/10.1016/j.matchar.2008.04.004. [3] H.I. Aaronson, J.T. Reynolds, G.R. Purdy, The incomplete transformation phenomenon in steel, Metall. Mater. Trans. A Phys. Metall. Mater. Sci. 37 (2006) 1731–1745. https://doi.org/10.1007/s11661-006-0116-9. [4] V.A. Esin, B. Denand, Q. Le Bihan, M. Dehmas, J. Teixeira, G. Geandier, S. Denis, T. Sourmail, E. Aeby-Gautier, In situ synchrotron X-ray diffraction and dilatometric study of austenite formation in a multi-component steel: Influence of initial microstructure and heating rate, Acta Mater. 80 (2014) 118–131. https://doi.org/10.1016/J.ACTAMAT.2014.07.042.
Requirements of the candidates / Requirements during the doctoral programme (courses, seminars, etc.)	Very good English command. Bachelor in Physics, Materials Science, Chemistry or related disciplines. Master in Materials Science or related disciplines. Knowledge of German 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.