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DocMASE Project Proposal DAAD-2015-1

Project Title	***Metal/Carbon Nanotube Composites: Synthesis and correlation between microstructure and properties***
Main University and Advisor	Saarland University, Prof. Dr. Frank Mücklich (Chair of Functional Materials)
Associated Partner(s) (if applicable)	Prof. Dr. Volker Presser (Saarland University: Nanotechnology of Functional Energy Storage Materials / INM: Energy Materials Group)
Project Description (with **image**, if applicable)	Carbon nanotubes (CNTs) have been foreseen as promising reinforcement candidates in composite materials. This is based on their high specific strength, high thermal and electrical conductivity combined with low density. The microstructure and physical properties of a composite can be tailored by the selective variation of the reinforcement phase fraction. The greatest challenge lies in preventing CNT agglomeration during the blending process with the matrix precursor. The Chair of Functional Materials has successfully optimized this process for Ni matrix composites. With this significant advance, it is possible to produce composites with high final densities and homogeneous distribution of the reinforcing phase. Our previous work has shown that it is possible to hinder the grain growth of metals with the addition of CNTs by a grain boundary pinning effect and hence exert influence on the microstructure. As described in project (c), ultrafine grained (UFG) and nano-crystalline (NC) materials exhibit excellent properties. However, the microstructural thermal stabilization still represents a major challenge of current research. UFG and NC composites can be produced by applying a strong deformation (e.g. high pressure torsion) on coarse-grained composites. In this context, the CNTs could help to control the grain growth at elevated temperature, thus stabilizing the physical properties. The aim of this project is the production of UFG and NC composite materials consisting of a metallic matrix (Ni, Cu, Al) reinforced with CNTs. Additionally, it is intended to obtain a deeper understanding of the interaction between the grain boundaries and the CNTs, and the evolution of the microstructure under thermal and mechanical loads. Furthermore, the mechanical and thermal properties of the composite materials should be optimized in order to enable a variety of applications (for example, electrical contacts).
Previous Publications	1. S. Suarez, F. Lasserre, O. Prat, F. Mücklich, Processing and interfacial reaction evaluation in MWNT/Ni bulk composites, Phys. Status Solidi. In Press (2014) 1–7. doi:10.1002/pssa.201431018. 2. S. Suarez, E. Ramos-Moore, B. Lechthaler, F. Mücklich, Grain growth analysis of multiwalled carbon nanotube-reinforced bulk Ni composites, Carbon 70 (2014) 173–178. 3. S. Suarez, F. Lasserre, F. Mücklich, Mechanical properties of MWNT/Ni bulk composites: Influence of the microstructural refinement on the hardness, Mater. Sci. Eng. A. 587 (2013) 381–386. 4. S. Suarez, A. Rosenkranz, C. Gachot, F. Mücklich, Enhanced tribological properties of MWCNT/Ni bulk composites – Influence of processing on friction and wear behaviour, Carbon 66 (2014) 164–171.
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. 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.