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DocMASE Project Proposal 2014-06

Project Title	**Microstructure investigation and property development of Advanced High Strength Steels**
Main University and Advisor	Luleå University of Technology (Sweden) Senior Lecturer Esa Vuorinen, PhD
Second University and Advisor	Saarland University (Germany) Prof. Frank Mücklich
Project Description (with **image**, if applicable)	Advanced High Strength Steels (AHSS) with microstructures consisting of ferrite and austenite, created by control of the chemical composition and the austempering process have high strength in combination with high toughness. Novel heat-treatment process comprising of quenching to a controlled temperature followed by partitioning (Q&P) of the carbon to austenite gives the possibility to shorten the total phase transformation times of welding and austempering treatments. The austempering process of Si-alloyed steels and the Q&P process used by a novel mean in welding and press-hardening applications have been investigated at LTU [1-5]. Wear resistance and fatigue resistance properties of steels with ferritic-austenitic microstructures have been studied and compared with steels with other microstructures. The ferritic-austenitic microstructure show very good wear resistance [5-8]. The work performed so far shows that the wear and fatigue resistance as well as the use of the novel heat-treatment process in order to increase the phase transformation rate in different material processing methods have several benefits, but that there are a number of questions that have to investigated more in detail. The project will have the goal to broaden and deepen the knowledge about AHSS steels with multiphase structures in one or several of the following areas; • To improve the knowledge of the TRIP-effect on the wear resistance of multiphase steels containing retained austenite. • To investigate the fatigue properties of multiphase steels and the influence of different micro-constituents on especially the σ_{UD}/R_m ratio. • To investigate the fracture crack behaviour in multiphase steels by in-situ SEM measurements of tensile and other mechanical tests. • To investigate the effect of quenching and partitioning treatment in welding and/or other technological processes in order to get detailed information of possibilities and limitations of this novel treatment method. • To investigate the quenching and partitioning process in-situ by high-temperature XRD measurements.
Previous Publications	1. In-situ high temperature X-ray studies on bainitic transformation of austempered silicon alloyed steels. Vuorinen E. and Chen X. (2010). Proc. 6th Int. Conf. THERMEC 2009. Materials Science Forum No 638-642, 3086-3092. 2. Weldability of hardenable silicon alloyed spring steel. Vuorinen, E., Bax, B. and Navara, E. (2010). Proc. 1st Conf. Acta Metallurgica Slovaca, 247-254. 3. In-situ high temperature X-ray studies of austempering transformation in high silicon cast steel. Chen X. and Vuorinen E. (2009). ISIJ International, 49(8), 1220-1224. 4. In situ x-ray observation of bainitic transformation of austempered silicon alloyed steel. Chen X, Vuorinen, E. J.Mater.Res., Vol.24. No.4, Apr 2009. 5. Materials selection for saw mill dust cutter blades. Vuorinen E, Lindström A, Rubin P, Navara E, Odén M. 2nd World conference on Pellets, 30 May – 1 June 2006, Jönköping Sweden. 2006. 6. Wear characteristic of surface hardened ausferritic Si-steel. Vuorinen E, et al.. Sino-Swedish Structural Materials Symposium 2007, J. of Iron and steel research Int. 14 (1) p245-254. 2007 7. Tribological behaviour of carbide-free bainitic steel under dry rolling/sliding conditions. Leiro A., Kankanala A., Vuorinen E., Prakash B. Wear 273 (2011) 2-8. 8. Wear of nano-structured carbide-free bainitic steels under dry rolling-sliding conditions. Leiro A., et al., Wear, 298–299, (2013) 42-47.
Requirements of the candidates / Requirements during the doctoral programme	Very good English command. Bachelor and Master in Materials Science, Chemistry, Physics or related disciplines. In addition to 3 years of research work, the candidate has to take courses and accumulate about 50-60 ECTS credits, which corresponds to 1 year of studies.