The effect of Differential Speed Rolling processing combined with multi-variant heat treatment on structure and properties evolution of Haynes 282 nickel-based superalloy

High temperature nickel based alloys are the most advanced structural metallic materials – there must be the reason why we call them superalloys. Due to an outstanding combination of high temperature strength and corrosion resistance nickel superalloys are right now (and still will be for many next years**) irreplaceable** in the most crucial application in transportation, manufacturing and energy production sectors. Mechanical and performance properties of nickel superalloys are controlled by a selection of alloying elements (chromium, cobalt, molybdenium, titatium etc.), but also by a proper design of fabrication and processing techniques.

Haynes 282 alloy is newly developed age hardened, wrought nickel-based superalloy designing for high temperature applications. This wrought alloy may successfully substitute actually applied superalloys (e.g. Inconel 718, Waspaloy, R-41) in many gas turbine engine applications by substantially exceeding their working temperature limitations. Furthermore, an excellent weldability and processability of the alloy put it in a good accordance with actually proposed designing trend to substitute large one-piece casting components with those made of joined small wrought parts with simple shapes (e.g. sheets or small forgings). However, one of the reported drawbacks of Haynes 282 sheets that ought to be corrected, is an undesired high mechanical properties anisotropy (what means that material exhibits different mechanical properties depending on a measurement direction). The results presented in only few available papers point toward that this unfavorable effect comes from a non-uniform banded structure and a presence of carbide stringers formed upon a thermomechanical processing. On the other hand, there is no available data giving the answer on the following question: **can we control Haynes 282 microstructure by modifying the cold rolling process? In what extent?** Due to a very good performance properties it is really important to develop a processing technology that allows receiving Haynes 282 sheets with both high strength and high formability.

One of the novel approach to a fabrication of metallic sheets is a **Differential Speed Rolling (DSR)** method. In general, this method is very similar to a conventional cold rolling – the difference is in DSR method the upper and lower rolls do not rotate with equal speeds. As a consequence, a material undergoes a larger deformation upon processing than in equal speed rolling – beside of a thickness reduction, an intensive shear strain also takes place. Results of already reported works (also these co-authored by the Principal Investigator of the project) show that a proper selection of DSR parameters allows obtaining materials with substantially different structure and properties than those of their counterparts subjected to the conventional rolling process. It has been documented that DSRed materials are characterized by a significantly refined grain structure (a grain size below 1 μm) and a more favorable distribution of particles in the materials matrix (what strongly improves both mechanical strength and mechanical properties anisotropy).

However, it is worth noted that so far there is a lack of available reported data on structure, texture and mechanical properties evolution of nickel based superalloys (including Haynes 282) subjected to the DSR process**. Therefore, the planned study on the effect of DSR parameters (i.e. an accumulative strain, a rolls speed mismatch) and applied heat treatment (temperature/time of solution and age-hardening treatments) on a structure and mechanical and thermophyscial properties evolution in Haynes 282 alloy, will be an original contribution to the actual state of knowledge. Moreover, a planned examination of structure stability upon long-term annealing will be also conducted to evaluate a possible usefulness of obtained Haynes 282 plates in terms of their usage.**

A completion of aforementioned research tasks will need an usage of both standard and advanced material's characterization techniques including: static tensile tests and micro/nano hardness measurements; scanning (SEM) and transmission (TEM) electron microscopy; electron backscatter diffraction (EBSD); X-ray diffraction (XRD); dilatometry, differential scanning calorimetry (DSC) and laser flash analysis (LFA).