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Tailoring of Metastable Steels

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Introduction

Metastable steels, like maraging and TRIP steels, are very attractive for various applications because of their good combination of corrosion resistance, strength, formability, crack resistance etc. Due to the strain induced martensitic transformations (Figure 1) in these materials the processing route (Figure 2) must be designed carefully keeping in mind the interaction between the processing history and final product properties.

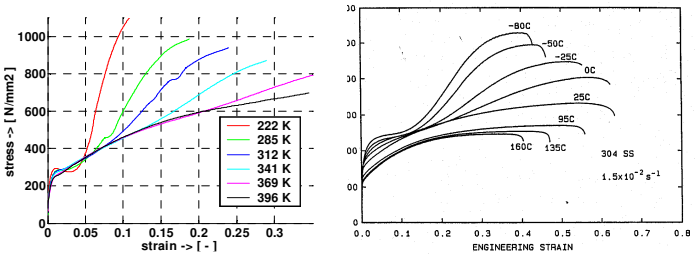

Figure 1: Stress-strain relation of Sandvik Nanoflex™ and type 304 stainless steel at different temperatures.

Figure 2: Example parts produced of metastable steels.

Objective

The aim of this research is to provide a numerical tool for the full-scale prediction of the manufacturing processes of metastable steel parts and for prediction of the mechanical and geometrical properties of these parts.

Methods

Translation of Micromechanical Models The focus of this part of the project is mainly developing macroscopic constitutive models by translating micromechanical models. These will include the following parameters mainly: Isotropic hardening, phase fraction contents, nucleation and growth mechanisms, thermal effects, anisotropy, non-proportional deformation and thermodynamic aspects. Experimental results of a previous study [1] will be used to evaluate the constitutive model.

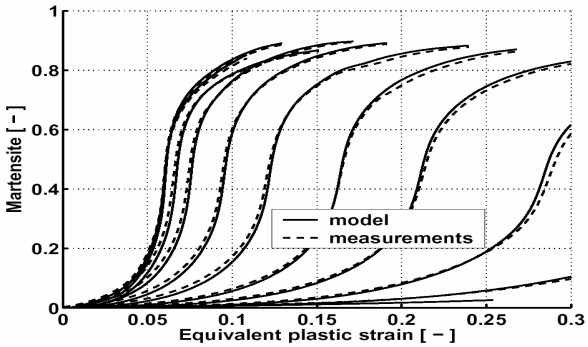

Figure 3: Induced martensite transformation behaviour of Sandvik Nanoflex™ at different temperatures.

Developing Algorithms This part of the project is focused on developing algorithms for efficient solution of simulations of forming of phase transforming materials. The FEM results will be compared to biaxial and tension test experiments' results. (Figure 4)

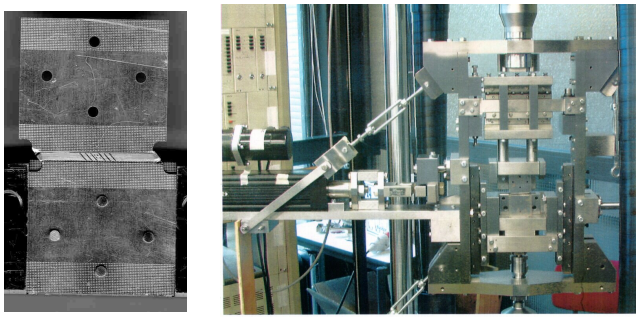

Figure 4: Biaxial test specimen and biaxial test equipment.

Optimization The concluding part of the project is to optimize the microstructure and processing routes to satisfy the final functional requirements.

Future work

- Further study on physical metallurgy on martensitic tranformations and non-linear FEM.
- Developing a complete simulation tool to predict the behavior of phase transforming materials.
- Optimization of production of desired metastable steel products.

References

[1] Post J. *On the Constitutive Behaviour of Sandvik Nanoflex.* PhD Thesis, University of Twente, 2004.

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