ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ

ΤΜΗΜΑ ΜΗΧΑΝΟΛΟΓΩΝ ΜΗΧΑΝΙΚΩΝ

ΑΝΑΚΟΙΝΩΣΗ - ΠΡΟΣΚΛΗΣΗ

ΔΗΜΟΣΙΑ ΥΠΟΣΤΗΡΙΞΗ ΔΙΔΑΚΤΟΡΙΚΗΣ ΔΙΑΤΡΙΒΗΣ

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Προσκαλούμε τους μεταπτυχιακούς και προπτυχιακούς φοιτητές μας, τα μέλη Δ.Ε.Π., τους διδάσκοντες του Τμήματος και κάθε ενδιαφερόμενο, στη δημόσια υποστήριξη της Διδακτορικής Διατριβής της κ. Τζίνη Μαρίας-Ιωάννας με τίτλο:

Σχεδιασμός της Θερμομηχανικής Κατεργασίας Χαλύβων Υψηλής Αντοχής και Χαμηλής Κραμάτωσης (HSLA Steels) / Design of the Thermomechanical Control Process of High Strength Low Alloy (HSLA) Steels

The design of the Thermomechanical Control Process (TMCP) of HSLA steels remains challenging and few attempts have been made towards optimization through a unified computational framework. Most studies are concerned with optimizing single stages of the TMCP, often neglecting the connection between the phenomena which control the microstructural evolution at different stages, while other studies are based on a trial-and-error procedure and require a large set of experimental data to improve the mechanical properties of the material. The TMCP of X70 HSLA steels consists of a two stage multipass hot-rolling in the austenite region (roughing and finishing), followed by controlled accelerated cooling, where the deformed austenite transforms into ferrite. After a coiling process, depending on the processing parameters, the final microstructure may consist of quasi-polygonal ferrite, acicular ferrite or bainitic ferrite, with an average grain size of 2-6 μm. The present study aims at the development of an integrated computational and optimization approach to describe the grain size evolution and distribution during the multiple stages of the TMCP in an X70 HSLA steel.

Two computational modeling and optimization approaches for the design of the TMCP of an X70 HSLA steel are presented. The first approach adopts an extended Johnson-Mehl-Avrami-Kolmogorov (JMAK) rate model to describe the strain-induced precipitation of niobium carbonitrides and static recrystallization of austenite during TMCP. Aiming at grain size refinement, a genetic algorithm was employed to determine an optimal processing route under specific process design criteria, resulting in the "trial material". In the second approach, a novel integrated precipitation and recrystallization model was developed, limiting the number of adjustable parameters, and was incorporated into a physically-based mean field model for the description of microstructural evolution. The model considers an effective Zener pinning force, an effective mobility for the solute drag effect of niobium and an inhomogeneous stored energy. A list of optimal processing routes was determined by the NSGA-II, solving a multi-objective optimization problem. These routes were characterized by a trade-off among the microstructural objectives, i.e. the average ferrite grain size, the niobium in solution and the degree of pancaking at the end of the finishing stage. A single processing route was selected, resulting in the "optimal material", and the microstructural evolution during TMCP was further investigated by Multi-Phase Field (MPF) calculations. Microstructural and precipitation analysis, as well as mechanical tests were carried out to characterize the two materials. The experimental data revealed a good agreement with the model predictions. Furthermore, a comparison between the MPF and an extended JMAK model is made for the case of C-Mn steels to reveal the controlling parameters of the temporal grain size evolution, and the MPF results are validated with experimental results reported in the literature.

Comparison between the two proposed trial and optimal materials and a reference material, derived by an industrial rolling schedule, showed that the optimal material had a finer and more homogeneous grain size, thereby it achieved the design objectives. However, it exhibited a slightly higher ductile to brittle transition temperature. The present study achieved to describe the phenomena controlling the microstructural evolution during the entire TMCP of HSLA steels via an integrated computational modeling approach, and reduce the required time for improving the material though an optimization procedure under set microstructural objectives. A step away from trial-and-error alloy development and towards the computational alloy design and optimization has been made. The proposed approaches can contribute to the process design of the HSLA and other microalloyed steels with improved material properties.

Πέμπτη, 21 Ιανουαρίου 2021, ώρα 17:00.

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