Structural and mechanical factors of the strengthening and recrystallization of hot plastic deformation of steels with microadditives

Elżbieta Kalinowska-Ozgowicz
Institute of Engineering Materials and Biomaterials, Silesian University of Technology,
ul. Konarskiego 18a, 44-100 Gliwice, Poland
Corresponding e-mail address: elzbieta.kalinowska-ozgowicz@polsl.pl

Abstract

Purpose: *The aim of the effect of high-temperature plastic deformation on the mechanism of strengthening and recrystallization of structural steels with trace elements, as well as their effect on the structure and properties of metallurgical products in the technique of controlled rolling. An integral aim is also to verify the method of mathematical and structural modeling in the process of shaping the structure and required mechanical properties of rolled products.*

Design/methodology/approach: *The realization of these aims required the application of modern plastometric techniques by hot torsion and compression, permitting both to determine the flow stresses and their changes in the continuous deformation process as well as the structural modeling of thermally activated processes, mainly static and dynamic recovery and static and metadynamic recrystallization determining the structure of the investigated hot deformed steels. In order to determine the morphology of the obtained structures and to identify the precipitations of the carbide, nitride and carbonitride phases in the investigated steels, methods of electron and X-ray diffraction were applied.*

Findings: *The flow curves obtained in the course of the plastometric investigations were used in modeling the process of dynamic recrystallization, taking into account the experimentally determined of the prior austenitic grains size. By means of the analytical method also the coefficients of constitutive equations was determined, describing the assumed model of a high-temperature plastic deformation of the investigated steels. In experimental investigations of the kinetics of thermally activated static processes, however, a new technique of assessing the degree of softening of the plastically deformed austenite during the isothermal holding was used, applying the method of the relaxation of stresses.*

Research limitations/implications: *The basic factor limiting the range of the structural analysis of the tested with microadditives steels, deformed at a temperature of stable austenite is the occurrence of phase transformation in the course of cooling, which makes it impossible to observe directly the changes taking place in the deformed solid solution γ.*

Practical implications: *The obtained results of investigations within the range of mathematical and structural modeling, as well as the simulation of the processes of high-temperature deformation and recrystallization constitute a basis for the elaboration of modified techniques of industrial of hot working, particularly controlled rolling of economical sections of the tested structural microalloy steels. The practical realization of this process will allow to get optimal mechanical properties and a warranted crack resistance at low temperatures.*

Originality/value: *The achieved scientific and practical aims, presented in this monography, provide essential and complementary knowledge in the field of material engineering, particularly the explanation of the mechanisms of deforming strengthening and recrystallization processes of the tested structural steels with microadditives. They also permit it to obtain a fine grained structure and require mechanical properties of the final products and to design technological processes in industrial conditions.*

Keywords: *Hot deformation, Recrystallization kinetics, Precipitation, HSLA steels, Microstructural evolution, Modeling and prediction*

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