POLITECHNIKA ŚLĄSKA W GLIWICACH

Wydział Mechaniczny Technologiczny

mgr inż. Liwia Sozańska-Jędrasik

PRACA DOKTORSKA

Struktura i własności nowoopracowanych stali wysokomanganowych typu TRIPLEX

Promotor:
dr hab. inż. Janusz Mazurkiewicz, prof. P.Ś.

Promotor pomocniczy:
dr inż. Wojciech Borek

Gliwice, czerwiec 2020

ABSTRACT OF PHD THESIS

"Structure and properties of newly developed TRIPLEX high-manganese steels"

mgr inż. Liwia Sozańska-Jędrasik

The thesis characterizes the influence of thermo-mechanical treatment carried out in semi-industrial conditions and with the use of the metallurgical simulator Gleeble on the structure, properties and strengthening mechanisms two experimental Fe-Mn-Al-C high-manganese TRIPLEX steels: X98MnAlNbTi24-11 with micro-additives of Ti and Nb also the base X105MnAlSi24-11.

Tested steels belong to the group of high-strength steels (HSLA - High Strength Low Alloy), additionally they are characterized by a 15% lower density compared to typical structural steels. Relatively good plastic properties, very good strength properties while maintaining a high yield strength make tested steels an attractive material for potential applications for structures, especially where it is crucial to reduce the weight of the entire structure.

The tested steels are characterized by a multi-phase structure based on austenite with ferrite and carbides. The thesis proved that the structural state of the analysed Fe-Mn-Al-C alloys and arising from very good mechanical properties are the result of the impact of strengthening mechanisms associated with the release of κ carbides with stoichiometric composition $(Fe, Mn)_3AlC$, whose morphology and place occurrence can be controlled by thermo-mechanical treatment. It was confirmed that the intensity of κ carbide interaction is so high that it compensates for the interactions associated with the release of other types of carbides (including Nb and Ti) and changes in the morphology of austenite and ferrite in this type of steels.

As part of own research, thermo-mechanical treatment of the examined steels was performed, both in laboratory conditions in several variants on a Gleeble simulator and on a semi-industrial rolling line by analysing the effect of hot plastic deformation conditions and various cooling variants on the structure of the tested steels and the course of heat activated phenomena. Tests of mechanical properties involving static and dynamic tensile tests and impact tests as well as structural tests using light microscopy, scanning and transmission electron microscopy, and X-ray phase analysis. Structural and diffraction studies of thin films in a transmission electron microscope confirmed the occurrence in the investigated nanometric steels of κ carbides in their austenitic matrix, which is responsible for precipitation strengthening formed in the process of thermo-mechanical treatment. The use of diffraction tests in a scanning electron microscope (EBSD) allowed the assessment of the participation and morphology of ferrite, which participates and shapes precipitation processes in this type of steels.