Effect of microstructure refinement on mechanical properties of microalloyed steels subjected to the dynamic loading conditions

The thesis is focused on a complex analysis of the correlations between ultrafine-grained, precipitation strengthened microstructures and their mechanical response under dynamic loading conditions. As an effect of the analysis of the state-of-the-art, presented in the first part of the thesis, an initial assumption was taken i.e. the introduction of the additional strengthening mechanisms provided by precipitation as well as multiphase strengthening to the ultrafine-grained materials allows improving their mechanical properties - both the strength and ductility.

After verification of the initial assumptions, the experimental investigations have been planned. The proposed plan assumed that in the first stage, the manufacturing processes to produce ultrafine microstructures will be performed i.e. significant refinement to the submicron level will be achieved in the investigated materials. Different techniques of the microstructure refinement using top-down methods were adopted at this stage. This allowed to produce in the tested microalloyed ferrite and austenite both a strong refinement of the microstructure and different structural composition with different morphology of the individual components. Materials produced by various methods were then subjected to metallographic tests using techniques adequate to the degree of fragmentation and structural composition obtained. In the next stage of the study, the obtained materials were tested under both quasi-static and dynamic loading conditions. A wide range of research conditions and parameters was used, thus enabling to obtain a large number of results illustrating the relationship between the microstructures of the examined materials and their rheological properties. The latest available techniques of plastometric and microstructural tests were used to conduct the research.

The research and analysis carried out in the doctoral dissertation allowed to confirm the validity of the thesis and provided new knowledge that can be used to design and evaluate modern structural materials. Formulated final conclusions can be used for better understanding of the phenomena occurring in the modern ultrafine-grained materials, strengthened by the second phase particles. Particularly, the importance of the results presented in this work relates to the problem of possible improving of the mechanical response of investigated materials under dynamic loading conditions.