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Analysis of structural phenomena and their influence on properties of low carbon steels deformed in the SPD process

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This dissertation presents the results of tests on the evolution of the structure and properties of low-carbon ferritic steels deformed with the unconventional DRECE method (Dual Rolls Equal Channel Extrusion). This method has been developed at the Faculty of Mechanical Engineering of the Technical University of Ostrava and falls into category of SPD methods (Severe Plastic Deformation).

Experimental work included deformation of selected metallic materials in the form of bands (with dimensions: a_0 = 800 mm, b_0 = 60 mm, h_0 = 2mm) with the DRECE method based on a numerical simulation of the process, detailed characteristics of structural changes in IF and DC01 steels occurring during the deformation, and determination of mechanical properties of the tested steels. The deformed materials were subjected to microstructure tests using the following methods: LM, SEM, SEM/EBSD, XRD. In addition, micro hardness was determined and tensile test of samples of IF and DC01 steel.

Deformation parameters, which foster obtaining significant changes in the structure, grain fragmentation and increased strength properties while maintaining the useful ductility of the tested steel, were determined.

The results of structural tests were the basis for the development of original models of structure changes, in which characteristic stages of evolution of structural changes dependent on strain parameters were distinguished. It was indicated that the dominant mechanism of grain fragmentation into smaller volumes is intersection of micro shear bands. It has also been proven that the deformation with the DRECE method is associated with the disappearance of the rolling texture component, which reduces anisotropy of mechanical and physical properties. This, in turn, may result in a more uniform deformation in the subsequent stages of plastic processing.

This dissertation proposes a schematic representation of the relations between the parameters of the deformation process, structure components and mechanical properties of low-carbon ferritic steel shaped in the DRECE process.

The results of the tests are a synthetic approach to the analysis of a structure and mechanical properties of IF and DC01 steels after the deformation process with the SPD method. The results of tests presented this way, aimed at linking the strain parameters

with changes in the structure accompanying the deformation and the obtained mechanical properties of IF and DC01 steel have not yet been presented in studies on low carbon ferritic steels deformed with the unconventional DRECE method.