Background of nanoscale gradient formation in the structure of steel 9HF at hard plastic deformation

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The notion of multi-level nature of the deformation considers a deformed solid as a hierarchically organized multilevel system. The plastic flow of deformation develops consistently as a gradual evolution of the local shifts causing the crystal stability loss on the interconnected nano-, micro-, meso- and macroscale levels.

The origin of nanoscale gradient structure in thin foils, occurring in the surface layers of the back-up rolls of the rolling mill, made of steel 9HF, characterized by the original lamellar pearlite structure was investigated by electron diffraction microscopy [1].

Nanoscale (100 nm) level of gradient structure formation and phase composition was manifested, and its appearance was associated with the movement of the atoms of alloying elements in the process of thermomechanical impact on the steel 9HF samples. Mechanisms of the lamellar pearlite evolution in the process of steel deformation were revealed.

It was shown that the process of destruction of the cementite plates in steel was accompanied by the transfer of carbon atoms from cementite plates in the nuclei of moving dislocations with the subsequent formation of ferrite in the bulk of nano-sized cementite particles, by cutting plates and the movement of individual particles of cementite according to Geguzin-Krivoglaz mechanism in the fields of internal stresses.

Thus, it was found that steel deformation caused the gradient of carbon concentration in the samples of steel 9HF and the gradient of the volume fraction of cementite particles. Both gradients had nanometer scale.

References

1. V.V. Kovalenko, E.V. Kozlov, Yu. F. Ivanov, V.E. Gromov. Physical nature of the formation of gradient structure-phase states in steels and alloys. Novokuznetsk Ltd. "The printer" (2009) 557 p.