Influence of the number of cycles of severe plastic deformation on surface nanostructure formation in low-alloyed steel

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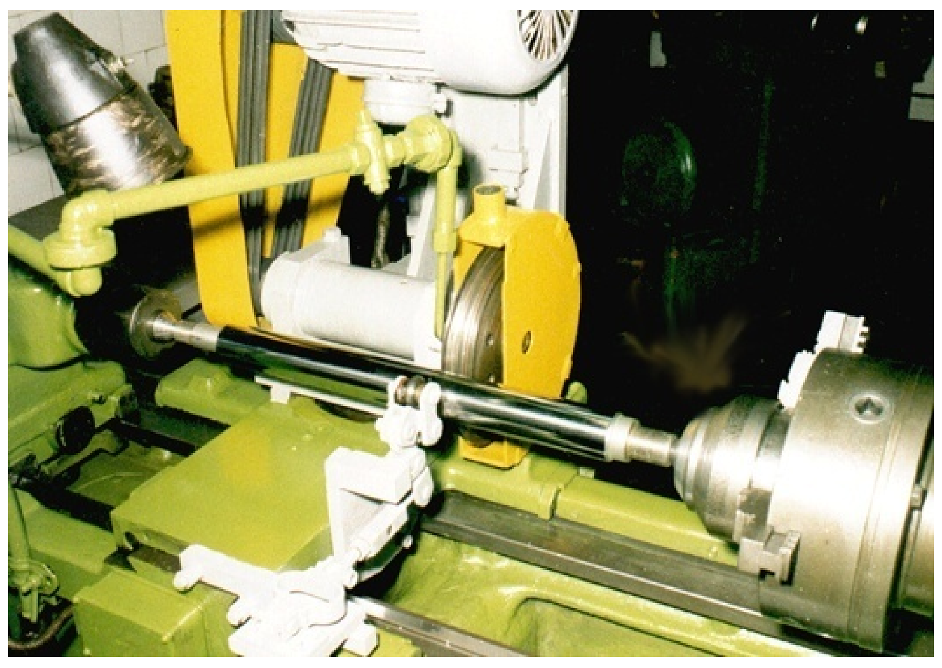
Introduction. **Mechanical-pulse treatment (MPT)** is one of the known methods of formation of surface nanocrystalline structures (NCS), which used high-speed friction for severe plastic deformation of the surface layer. Surface-grinding and treated-turning machines after insignificant modification can be used for MPT. Every point of steel surface under MPT is treated by strengthening tool several times passing through the friction contact (FC) zone, which indicates the number of deformation cycles which significantly effect on the formation of surface NCS and, consequently, on their properties.

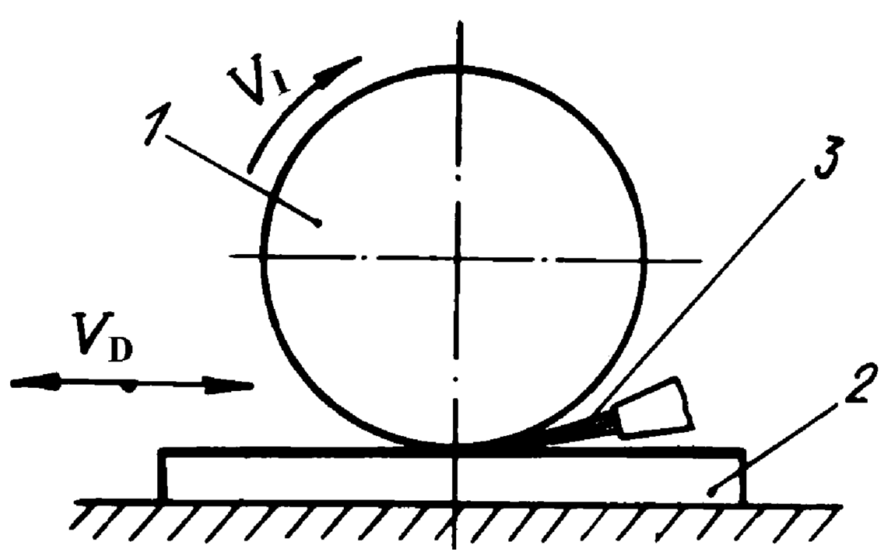
Aim. The aim of this work was to study the influence of the number of cycles of MPT on structure refinement and phase composition of the nanostuctured surface layer of 65Г steel (0.65C-1Mn).

Objective. The influence of the number of cycles of MPT on structure refinement and phase composition of the NCS layer of 65Г steel have been studied. The plane specimens with sizes of 40×20×3 mm were researched. The number of cycles of MPT changed from 1 to 6.

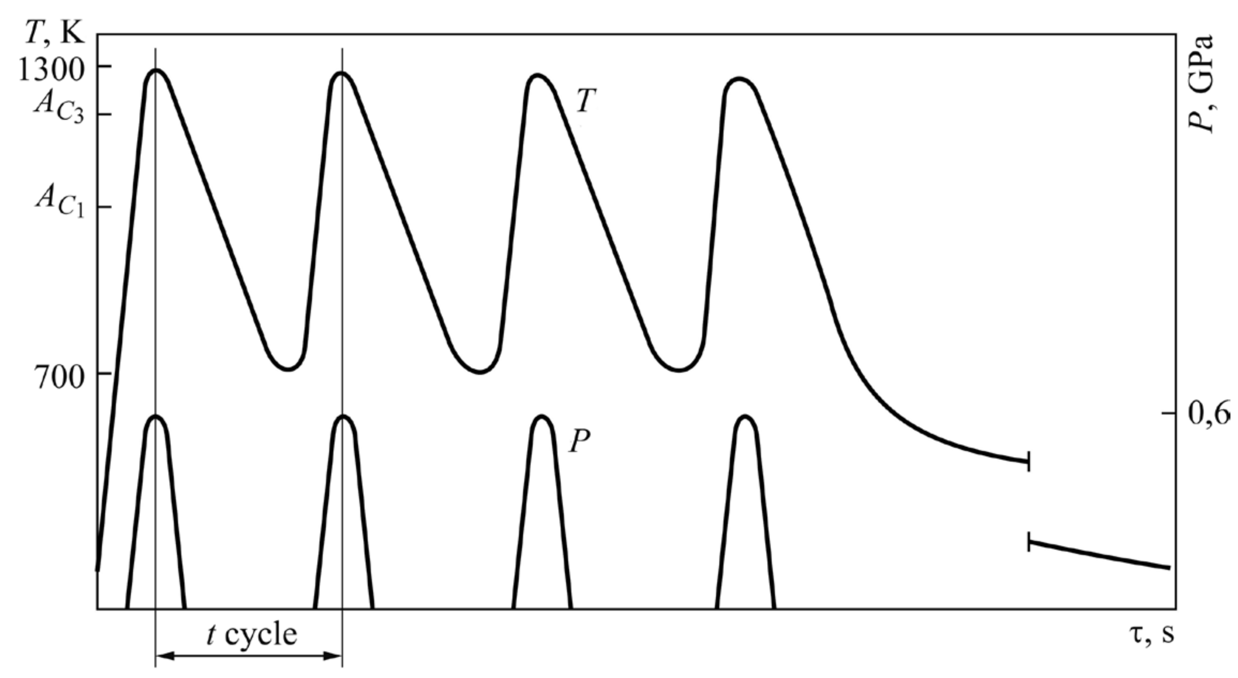
Results. It has been formed martensite-austenite-cementite structure with Fe_3O4 and FeO oxides on 65Г steel due to MPT. The phase correlation changed with variation of the number of cycles: martensite and retained austenite were the basic phases, but from the third cycle, the lines of oxides Fe_3O4, FeO and cementite Fe_3C became shaper on X-Ray diffraction patterns.



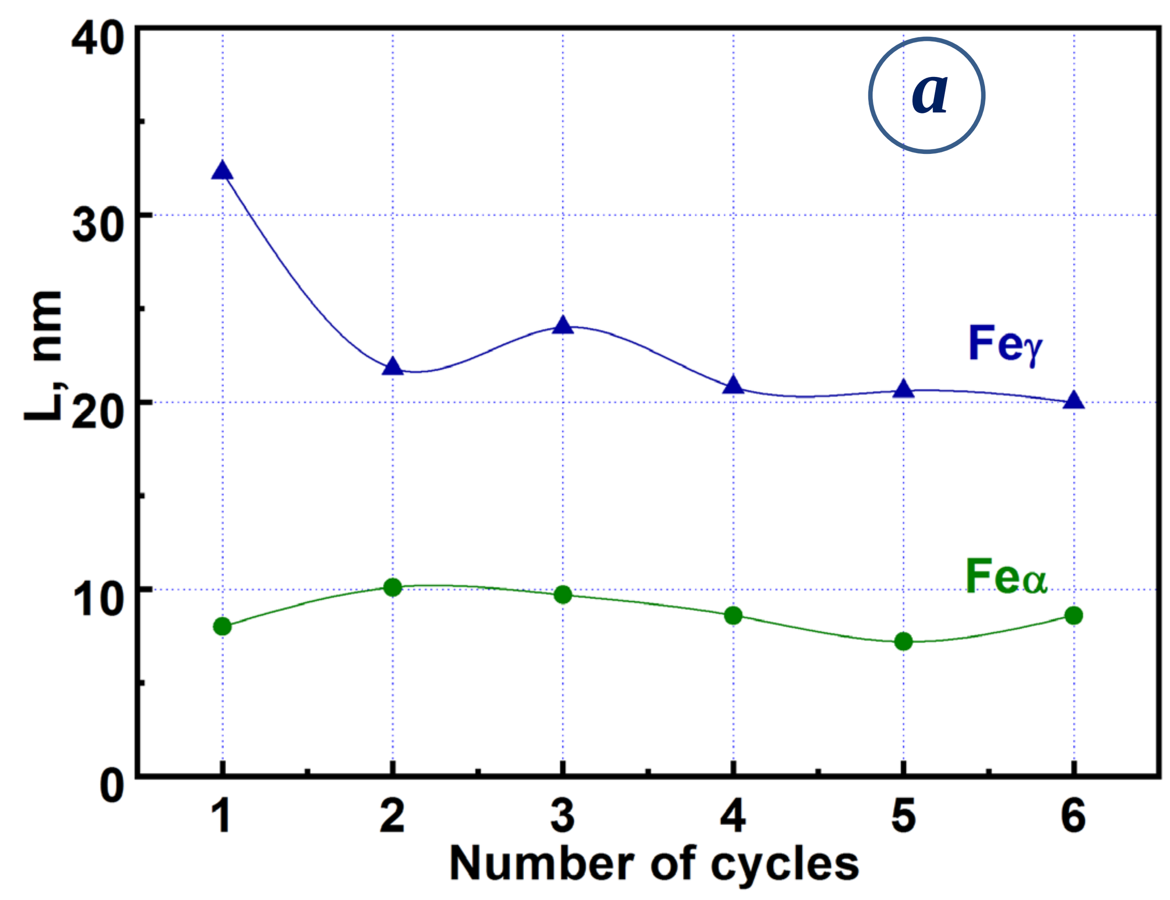
MPT equipment for cylindrical specimens

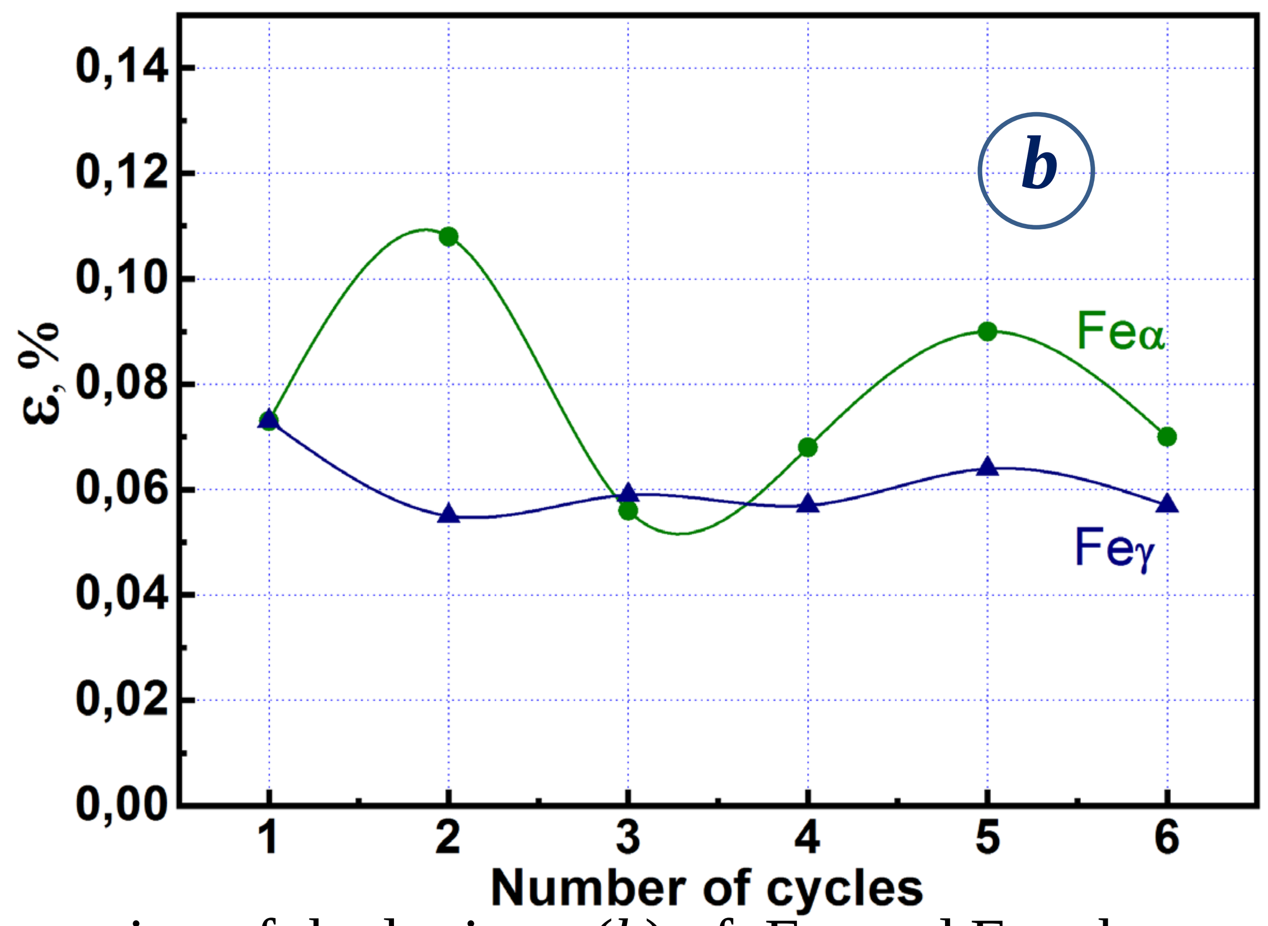


The scheme of MPT of plane specimens

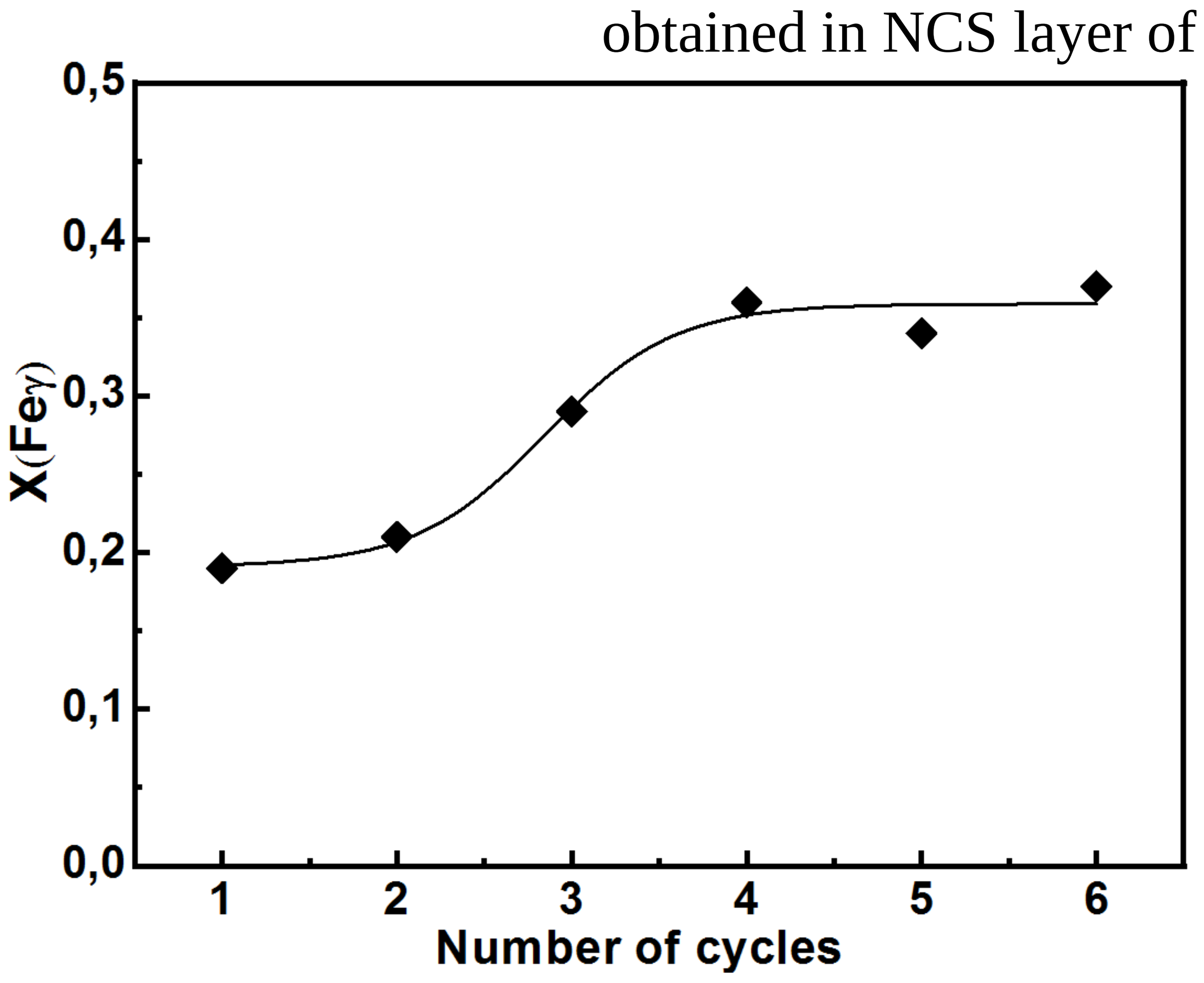


The scheme of cyclic change temperature T and pressure P in the FC zone during MPT

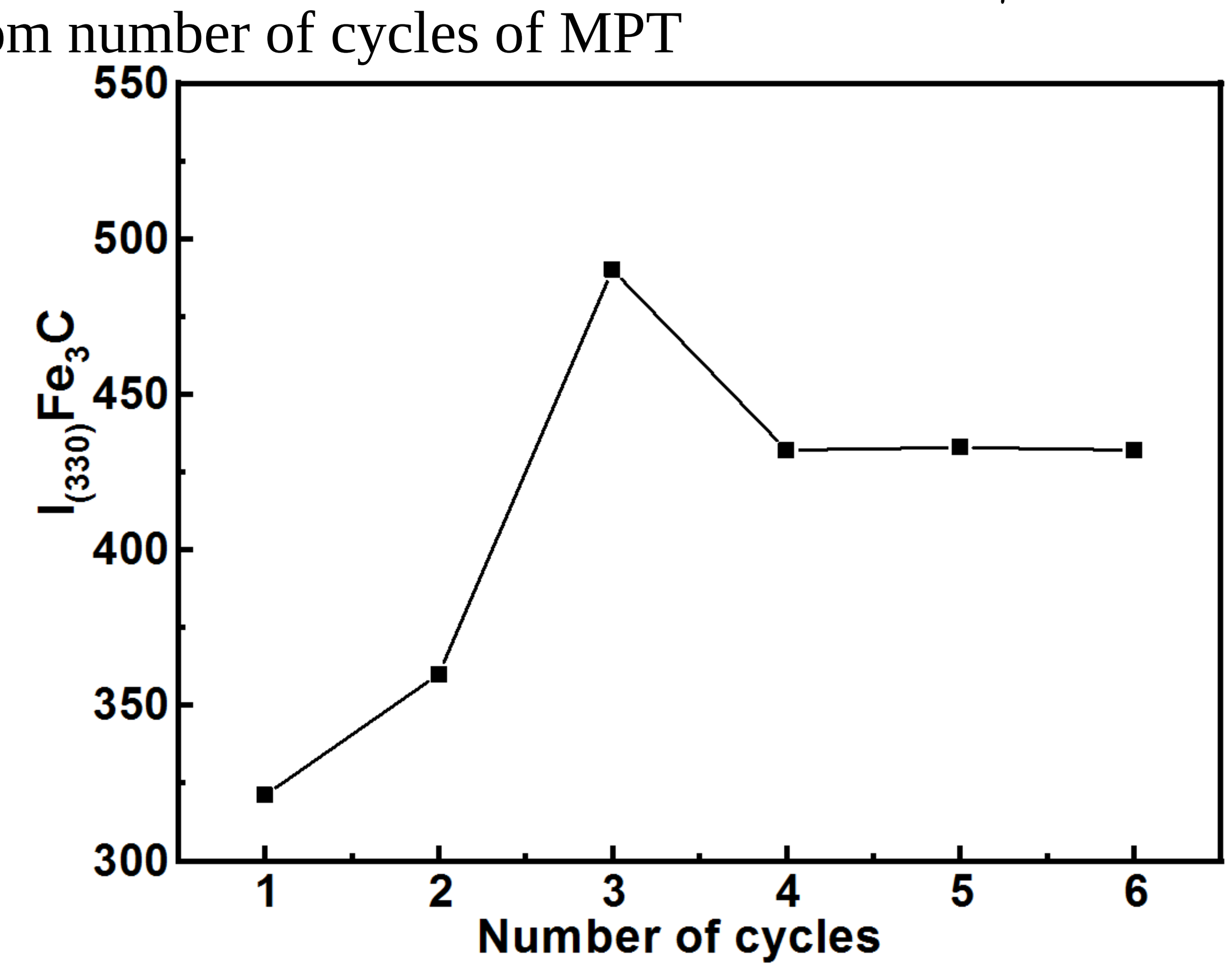




The dependences of the grain size L (*a*) and the related deformation of the lattice ε (*b*) of Fe_α and Fe_γ phases obtained in NCS layer of 65Г steel from number of cycles of MPT



The dependence of the volume fraction of austenite phase in the surface NCS obtained on 65Г steel from number of cycles of MPT



The dependence of the integral intensity I of Fe_3C peak (330) on X-Ray diffraction patterns obtained on 65Г steel from number of cycles MPT

Conclusions. The change of the number of cycles of MPT leads to the change of grain size L of the surface NCS layer, and it was stabilized after the second cycle of MPT. The number of cycles of severe plastic deformation during MPT significantly influences on related deformation of the lattice of martensite (Fe_α) and austenite (Fe_γ): the related deformation of the austenite lattice was stabilized after the second cycle of MPT while the change of related deformation of the martensite lattice was cyclical. The amounts of retained austenite and cementite in the surface NCS layer were stabilized after the fourth cycle of treatment. The phase composition of the surface layer with NCS, its grain sizes and the level of internal stresses defined the physical and mechanical properties of the steel. Therefore, obtained results are important for receiving optimal combination of properties of the surface layer and efficiency of MPT.