Factors affecting nanograin formation during mechanical-pulse treatment

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Introduction. **Mechanical-pulse treatment (MPT)** is one of the known methods of formation 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. Thermostressed state of a metal in the friction contact (FC) zone is influenced by variation of treatment regime of MPT. Hence, the parameters of the treated layer, namely grain's size on the surface and its thickness can be changed in that way.

Aim. The aim of that work was to establish the dependence between treatment regimes of MPT and parameters of strengthened surface layer (namely, grain size D on the top surface and the thickness of strengthened layer δ) and consequently on its properties.

Objective. MPT of 65Г (0.65% C, 1% Mn) steel was carried out at different treatment regimes to study their influence on the parameters of the strengthened surface layer.

Results. NCS with the grain size range 16 – 40 nm were formed on 65Г steel's surface due to variation of treatment regime of MPT. At that time, the surface microhardness decreased from 9.8 to 7.7 GPa accordingly. It was also established that increment of the thickness of strengthened layer and decreasing its grain size led to increasing of contact fatigue (number of cycles before destruction) of treated steel.

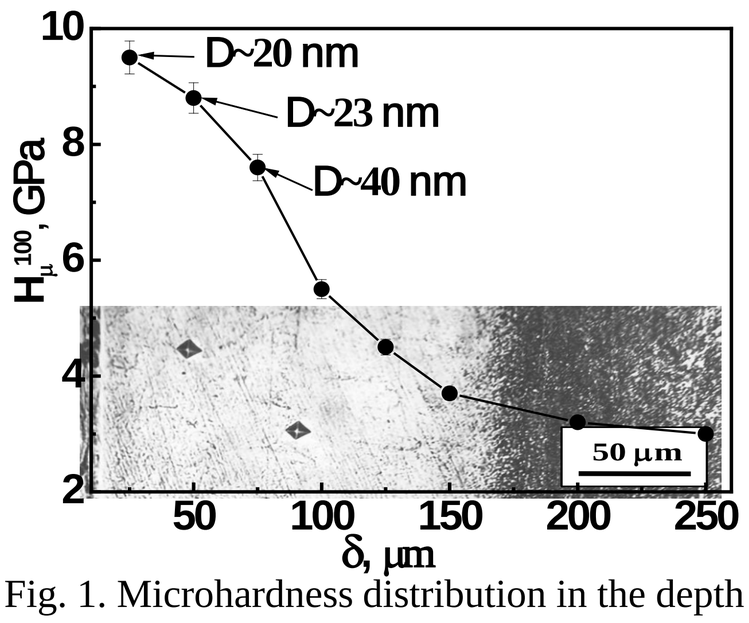

Fig. 1. Microhardness distribution in the depth and the fragment of the surface layer with NCS of 65Г steel

The treatment regimes of MPT were variated in the following ranges:

- specimen rotation velocity V_s 0.12 – 0.29 m/s,
- longitudinal feed of the strengthened tool relative to the specimen S – 0.8 – 1.2 mm/rev.,
- specific pressure P – 0.48 – 0.80 GPa.

Tool rotation velocity was 50 m/s.

As cooling technological medium was used industrial oil 1-12A.

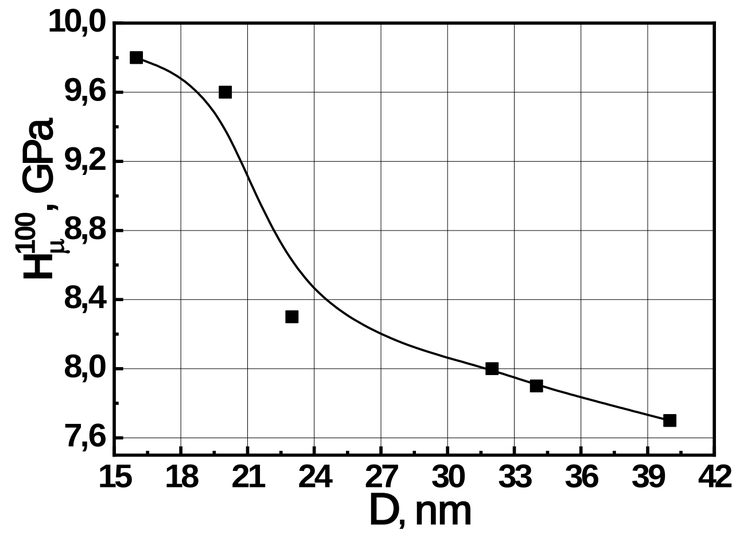

Fig. 2. The microhardness of the surface layers with NCS formed by MPT on 65Г steel with different grain sizes

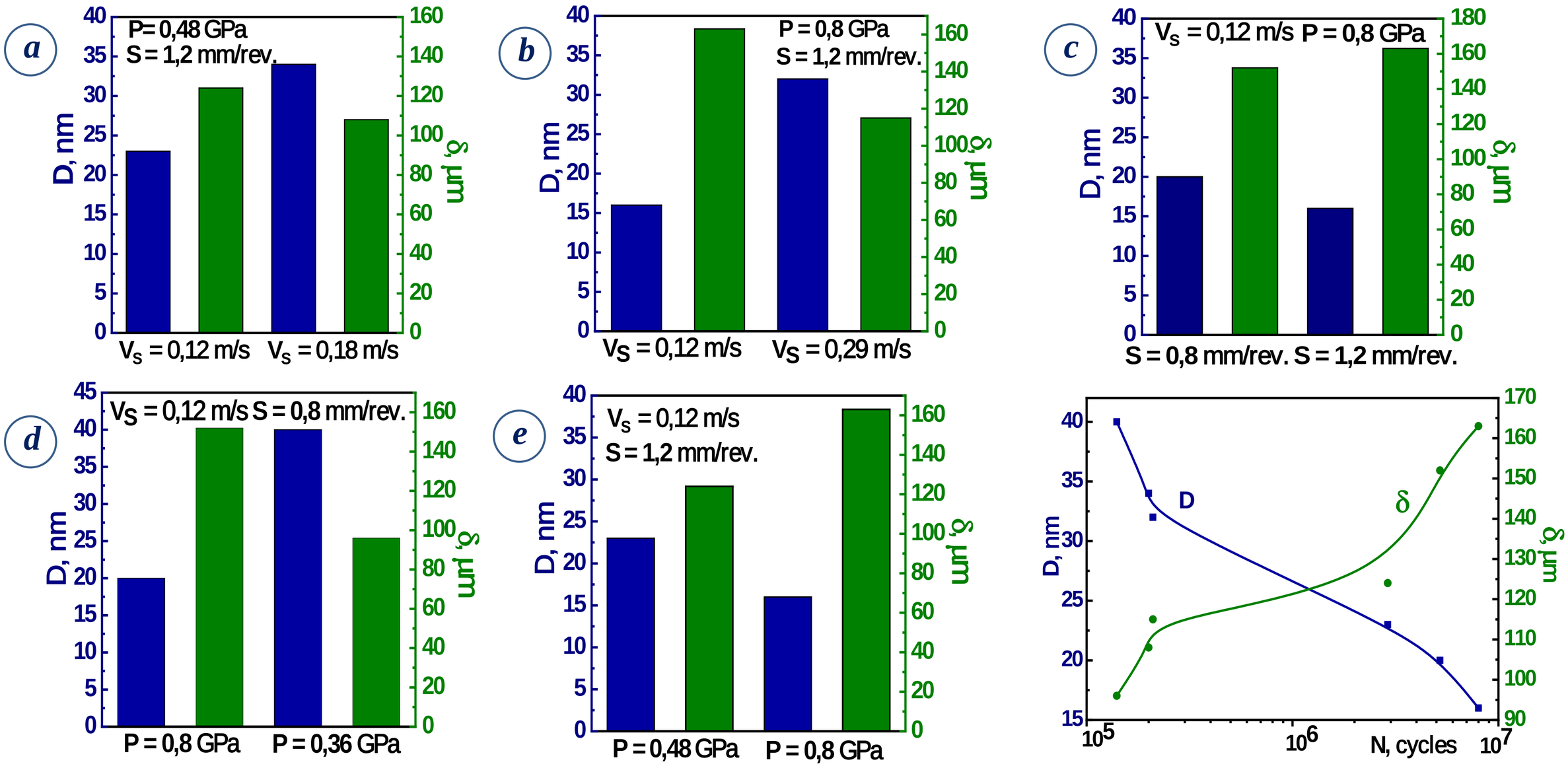

Fig. 3. The dependence of the parameters of NCS (grain sizes D and thickness of the strengthened layer δ) from the parameters of MPT (specimen rotating velocity Vs (*a*, *b*), longitudinal feed of the strengthened tool relative to the specimen S (*c*), specific pressure P in the FC zone (*d*, *e*))

Fig. 4. The dependence of the contact fatigue of 65Г steel in the oil from grain sizes D and thickness of the surface layer δ

Conclusions. Based on carried out researches, the following main regularities were determined: i) increment of the specimen rotating velocity resulted in raising the grain size and decreasing the thickness of the layer ii) due to raising of the pressure in the FC zone, the grain size decreased and the thickness of the layer increased; iii) due to raising of the longitudinal feed of the tool relative to the specimen the grain size slightly decreased and the thickness of the layer slightly raised. Therefore, the technological regimes of MPT significantly influenced on formation of the surface layers with NCS and then on their properties. Based on carried out researches, it was established that the technological regimes of MPT significantly influenced on formation of the surface layers with NCS and then on their properties.