Nanostructured surfaces

Influence of hydrogen on the mechanical properties of steels with surface nanostructures

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Nanocrystalline structures (NCS) attract presently a considerable attention of physicists due its unique properties related to size effects. The actual task for this research direction is a development of high-productive, cost-effective and environment friendly technologies for a production such structures with high mechanical properties, in particular, in working environments. The technology for production of surface thermoplastic NCS on metals by severe plastic deformation (SPD) due a high-speed friction, is developed. The technology consists in a rapid heating of surface layer by a friction of the special metal tool and working component to subcritical temperatures and rapid cooling in the technological environment (TE). The rate of shear plastic deformation of reaches under such conditions of 10^2–10^3 s^{-1}. This leads to the formation of surface gradient NCS layers in depth up to 800 μm with grain size on surface even 12–20 nm. The structural-phase changes and a saturation of surface layer by the TE elements because of their destruction in frictional contact area take place due to rapid heating and cooling.

Effect of hydrogen on mechanical properties of the NCS is actual presently. It is shown in this paper that the preliminary electrolytic hydrogenation of the plane specimens of steel 65G (0.65C-1Mn) and 40Kh (0.45C-1Cr) treated for the NCS on both sides, influences on the characteristics of strength and plasticity of composite “gradient NCS surface–matrix”. These mechanical characteristics depend on the initial structural state and the tempering after SPD. The best complex of strength and ductility was obtained after a tempering at 500° C. Moreover, reduction of area of hardened composite is greater than for unstrengthened material. A using the special tool which provides multidirectional sliding thermoplastic deformation of surface layers increases additionally strength and plasticity characteristics of the studied steels in air and after hydrogenation.