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THE FUNDAMENTAL THERMODYNAMIC RELATION ON CONTACT SURFACES OF MULTICOMPONENT NANOCOMPOSITE COATINGS

Voskoboynik M. V., student; Dyadyura K. O., professor,
Sumy State University, Sumy

The increasing demands of modern engineering have spawned the development of new advanced materials for use. The development of advanced materials can be considered to be a typical problem of engineering optimization. In this process, an integrated engineering–physical approach is used to develop novel wear-resistant materials. Until now only a limited amount of investigations have been performed on the progression of the self-organization process during friction. Moreover studies made so far focused mostly on the characteristics of tribo-films. Information in the scientific literature on the interdependence of the characteristics of both tribo-films and underlying surface engineered layer during self-organization is even more limited. The key concept of this is associated with the tribological compatibility of two surfaces interacting during friction. The aim of this paper is to reveal the mechanism of adaptation of hard coating under extreme tribological conditions. The chief theme of this project is the application of concepts of irreversible thermodynamics and self-organization to tribology and the role played by physicochemical interactions in modifying and controlling friction and wear. The driving force of the self-organization process is the open system aimed to decrease entropy production during nonstationary processes. Spontaneous formation of dissipative structures is a result of symmetry perturbations that can be realized only in open systems, which exchange energy, matter, and entropy with their environments. This phenomenon is a focus of attention for many researchers in different fields of science. It has been found that different structure states (amorphous, metastable and stable crystalline phases) may by systematized and described using the common condensation mechanism with different non-equilibrium degree of the process. The non-equilibrium is caused by super-high cooling due to condensed atom thermalization that limits surface diffusion mobility. It is argued that the fractal dimension and multifractality of the polydisperse system are determined by thermodynamic conditions and material properties and can be regarded as the thermodynamic characteristics of the dispersed system.

All these problems are chosen to bridge the gap between fundamental interest in understanding the conditions leading to self-organization and practical motivation. We study the relationship between friction-induced instabilities and friction-induced self-organization. Friction is usually thought of as a stabilizing factor; however, sometimes it leads to the instability of sliding, in particular when friction is coupled with another process. The self-organization is usually beneficial for friction and wear reduction because the tribological systems tend to enter a state with the lowest energy dissipation.