Application of pulsed plasma in shaping the materials structure

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Forming the properties of materials consists in fulfilling the sequence of energy states of the material: obtaining the state of increased free energy, as the excited initial state for subsequent treatments and then controlled relaxation of this excess energy until reaching a lower level of energy imbalance determined by the assumed new grade of structural metastability in the phase aspect as well as in the morphological aspect; this grade determines the usable properties of the material as a synthesis product. Effectiveness in implementing the above sequence, which is crucial for obtaining the desired properties of materials, is directly dependent on the degree of recognition of the synthesis environment. In the case of plasma surface engineering methods, this effectiveness is conditioned by the necessity of ensuring at the same time sufficiently high levels: of the energy resource and the degree of plasma imbalance. The impulse processes that minimize the risk of uncontrolled arcing and electrode degradation at high power densities are the most beneficial from this ponit of view. The pulse of plasma processes also creates a unique chance for thermodynamic freezing of metastable states of synthesis products on cold substrates, difficult or impossible to achieve by other means. I define the plasma that meets the abovementioned features as an active synthesis environment, because such a plasma itself contains factors that directly determine the possibility of achieving high energy excitations of the original synthesis products.. The plasmas excited under standard conditions in DC processes could be considered the opposite of the plasma activity defined by me in this way. These plasmas demonstrate a low degree of ionization (e.g. several percent), and their effectiveness in the synthesis of materials and technologies of plasma surface engineering must be supported by energy supplied from external sources, e.g. thermal activation of the substrate, electrical polarization of the substrate, additional electromagnetic interactions on the plasma to increase the degree of its ionization, etc. In PA PVD processes, in which the synthesis of materials is carried out, the ability to achieve high energy excitations of primary synthesis products and, therefore, the specific non-equilibrium structure is clearly limited (e.g. it is extremely difficult to avoid the formation of a column structure). Such a plasma environment plays a kind of "tooling" role in the synthesis process, and thus it is only a rather convenient means of mass transport (because it is electrically and magnetically controllable in contrast to gas).

In the results of my research I tried to use or assign to plasma, which I used for the production of coatings, features that would maximize its activity attribute in the synthesis of materials. I have the impression that I was able to show in consequence that the plasma activity I was seeking for was reflected in the broadly understood structural features of the coatings I produce. The research concerning the active role of low-temperature plasma in the synthesis of materials was carried out using two method of plasma surface engineering: IPD (Impulse Plasma Deposition) and PMS (Pulsed Magnetron Sputtering) methods. These methods differ first of all from the plasma generation strategy, which consequently affects the amount of energy introduced into the gas environment, but in the case of both methods, especially with respect to the low energetic PMS method, the plasma created meets the criterion of activity in the context of synthesis.