

Designing of Bioceramic Coating with the Set Properties on Titanium Alloys

V.A. Mamaeva, T.I. Dorofeeva, and A.I. Mamaev*

*Institute of Strength Physics and Materials Science SB RAS, 8/2, Academicheskoy ave., Tomsk, 634070, Russia
Phone +8(3822) 28-68-74, Fax: +8(3822) 28-68-74, E-mail: vam-tomsk@rambler.ru*

** Advanced Equipment and Technologies for Electrochemistry Ltd., 4-a, Poimenii str., Tomsk, 634050, Russia
Phone: +8(3822) 40-08-67, Fax: +8(3822) 40-08-67*

Abstract – Research of morphology, structure, porosity, roughness, adhesion, nanohardness and biocompatibility of bioceramic coatings is a topical problem. High-energy pulse influence on the titanium and its alloys in electrolytic solutions is perspective for designing layered nanocrystal bioactive coatings and allows constructing coating formation process purposefully.

The microplasma processes in electrolytic solutions are the most advanced method for obtaining bioactive ceramic coatings containing hydroxyapatite or calcium phosphate combinations on titanium implants [1]. The bioactive ceramic coatings formed by microplasma processes in electrolytic solutions have nano- and micropores and nanocrystalline structure [2–3]. These coatings have strong adhesion, high corrosion protection and wear resistance.

The high-density current flow through electrode/electrolyte interface initiates electro-chemical reactions, microplasma discharges and current-sheet charging. A topical problem is the construction of bioceramic coating with set properties. For achievement of this purpose, it is necessary to research the mechanism of the fast pulsed microplasma processes, and to control the mechanism of the bioceramic coating formation.

The voltammetry characteristics are a source of the information about a nature of the electrode kinetics at electrochemistry and they allow control the contribution of the electrochemical and microplasma processes.

The advanced equipment of a second generation – Computer Aided Measurement System (CAMS) [3] was developed and used for investigation the process of the bioceramic coatings formation on titanium surface by pulsed microplasma processes in electrolytic solutions with different composition keeping as soluble and an unsolvable component such as hydroxyapatite and calcium phosphate. The voltammetry dependencies in electrolyte solutions with the different adds of chemical composition of calcium differ from each other.

CAMS improved technical and metrological characteristics. This equipment allows to record the voltammetry dependences of the pulsed microplasma processes

using the voltage amplitude up to 3000 V, the rate of change voltage up to 10^8 V/s, the currents up to 100 A with the original trapezoid form of the polarization pulsed voltage.

Our investigations have shown the voltammetry characteristics depend from a nature of electrode and an electrolyte composition, a time of process, an amplitude and pulsed duration of polarization voltage and reflect influence of the various factors on the process formation of the bioceramic coatings. It is possible to supervise thickness, porosity, pore size, roughness, structure, composition and properties of the bioceramic coatings using the voltammetry characteristics.

The using of this equipment and the recording of the cyclic voltammetry characteristics open a new possibility of scientific research and it is the new instrument for research kinetic and mechanism of bioceramic coatings formation and that is a new instrument for the bioceramic coating construction.

As a result of experimental researches, very large databank is received, allowing expecting properties of received coatings. The cyclic voltammetry characteristic is reflecting the influence of various factors at the given moment of the coating formation and to use this date for automation of the process of bioceramic coating formation.

The analysis of the voltammetry dependencies shows, that the registration of the voltammetry curves allows to carry out the entrance control of an electrode material and the process of bioceramic coatings formation, supervise and construct bioceramic coatings with given properties.

References

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