Laser micro- and nanostructuring of the Ti implants by nanosecond pulses

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Abstract

The report is devoted to the development of a laser method for creating an ordered relief on a metal surface for biomedical applications. The results of an experimental study on the formation of a specific microgeometry of the Ti-alloy surface are presented. Laser processing parameters have been developed to obtain microchannels with a given depth, width, and flattening radius. A theoretical and experimental study of the formation mechanism of nanoparticle agglomerates covering the surface of microchannels was carried out during laser ablation of the surface of a Ti-alloy. Based on the analysis of the structure and volume of the porous coating formed by nanoparticle agglomerates, which outwardly resembles a snow cover, an assumption was made about the mechanism of its formation, as the "precipitation" of a TiO^2 deposit from the laser plasma. The formulated hypothesis was convincingly confirmed both experimentally, from the analysis of the composition of the plasma and the coating, and theoretically, from the calculating the amount of reverse-deposited metal. The morphology, elemental, and phase composition of the subsurface layer of a laser-structured titanium alloy were studied by SEM, EDX in TEM, and Fourier transforms calculated from the HAADF-STEM. A theoretical calculation of the amount of reverse-deposited metal due to collisions in a plasma plume has been carried out. An in vitro confirmation of the effectiveness of the textured Ti-surface for biomedical applications, in particular, as a surface coating of dental implants, is presented.

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