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BIOACTIVE ZIRCONIA THIN FILMS FABRICATED BY DUAL CATHODIC ARC AND OXYGEN PLASMA DEPOSITION

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The materials surface plays an extremely important role in the response of the biological environment to the artificial medical devices. The initial protein interactions with implant surfaces are very important and therefore, it is clear that if the surface morphology, structure, composition, and properties are changed, cell functions are influenced. Nanoscale materials are thought to interact with some proteins more effectively than conventional materials and to mediate osteoblast functions due to their similar size and altered energetics. In our experiments, nano-structured zirconium oxide thin films are prepared by dual cathode arc and oxygen plasma deposition. The phase composition and structure of the zirconium oxide thin films were determined by X-ray diffraction (XRD), optical absorption spectra (OAS), and atomic force microscopy (AFM). The results reveal that the as-prepared zirconia films possess the primitive tetragonal phase. The films are also characterized by scanning electron microscopy (SEM) and surface potential analysis. After immersion in simulated body fluid (SBF) solution for a certain period, the nano-structured ZrO2 thin film can induce bone-like apatite to form on its surface, indicating that the thin film is bioactive. In addition, bone marrow mesenchymal stem cells are found to grow and proliferate in good states on the thin film surface. The zirconia thin films with both superior bioactivity and cytocompatibility have thus been successfully fabricated and it is believed that nano-structure and surface charge of the thin films play very important roles.

INFLUENCE OF FOCUSED SHOCK WAVES UPON A SONOSENSITIVE MATERIAL

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Interaction of two successive shock waves (tandem shocks) in water focused to a common focal point has been investigated. Amplitude of the compression part of the wave s as high as 100 MPa, while amplitude of the dilution part of the wave reaches down to -25 MPa in the focus. At that underpressure numerous cavitations are produced. It was demonstrated that the acoustical inhomogeneity created in water by the first wave strongly modifies propagation of the second one. Measurements of waveforms by PVDF shock gauges at the focus indicate that the second wave is strongly attenuated at some time delays between shocks. At time delays in the interval 50-500 µs the second wave is totally damped at the focus. Schlieren photography of the focal region demonstrates that the interaction of two successive shocks results in creation of a very complex pressure field at the focus to which contribute many secondary spherical short wavelength shocks that originate in collapsing cavitations. The tandem shock waves can be potentially applied to sonodynamic treatment of cancer tumors. Effect of the tandem shock waves on melanoma cells B16 has been investigated. Micro photographs of cells demonstrate that even a small number of shocks (100) result in perforation of cell membranes. At present an enhancement of treatment efficiency by the activation of sonosensitizers combined with the perforation of cell membranes is studied.