Developing nanostructured Ti Alloys for innovative implantable medical devices

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Recent years have witnessed much progress in medical device manufacturing and the needs of the medical industry urges modern nanomaterials science to develop novel approaches for improving the properties of existing biomaterials. One of the ways to enhance the material properties is their nanostructuring by using severe plastic deformation (SPD) techniques. For medical devices, such properties include increased strength and fatigue life, and this determines nanostructured Ti and Ti alloys to be an excellent choice for the engineering of implants with improved design for orthopedics and dentistry. Various reported studies conducted in this field enable the fabrication of medical devices with enhanced functionality. We review recent development in the field of nanostructured Ti-based materials and provide examples of the use of ultra-fine grained Ti alloys in medicine. Our studies have proven that nano structuring of titanium materials by means of severe plastic deformation (SPD) techniques achieving grain refinement, increase of dislocation density, dissolution and formation of secondary phase precipitations allows for considerable improvement of the strength and fatigue properties. The advantages of nano structuring were demonstrated for CP Ti, Ti alloys including new β-Ti alloys as well as the NiTi alloy with shape memory effect. The approaches to computer design of a number of miniaturized medical implants made from high-strength nanomaterials have been suggested. Study includes the examples of manufacturing and tests of selected advanced medical devices for traumatology and surgery from Ti nanobiomaterials. Taking into account the results of recent studies on surface modification, including chemical etching of nanometals and deposition of bioactive coatings, it is assumed that the developments of Ti-based nanomaterials opens new possibilities for advanced medical implants and devices with improved design and functionality.

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