Bio-Implants for HRQoL Applications: RSM Model Optimization of the Laser Processing Parameters to Improve Bio-Compatibility of Ti-6Al-4V Alloys

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With an aging population, war, and sports-related injuries, there is an ever-increasing demand for hard tissue replacements, such as bone. In fact, there has been a fourfold increase in the number of hip replacement procedures within the U.S since mid-2009. It has been concluded through studies that pure titanium and Ti-6Al-4V are well-tolerated materials under in vivo conditions. Ti-6Al-4V is a heat treatable and weldable alloy that exhibits high chemical stability and mechanical behavior. Recently, however, there has been great concern on the dissolution of aluminum and vanadium ions into the body fluid and the possibility of a toxic result, which is caused by poor integration with the human environment. Without the ability to attach and surround the biomaterials with osteoblast cells, the surrounding tissue will recede from material, release ions or debris, and thereby require immediate revision surgery. In order to reduce this effect, it is necessary to nullify factors such as inferior corrosion and wear resistance that can be linked with poor osseo-integration. Laser surface processing is an innovative method that creates a physical texture on Ti-6Al-4V alloys and has been hypothesized to improve bone integration and tissue growth on metallic implants. This form of engineering will be used in this study whose goal is to find the optimal laser processing parameters, based upon laser fluence values, to improve Ti-6Al-4V alloy’s biocompatibility. Contact angle, surface energy, roughness, and microstructure measurements were taken. Through response surface analysis based on central composite model, the optimal parameters was concluded.

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