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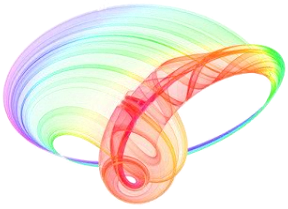

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Laser induced mixing in multilayered Ti/Ta thin film structures

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Metallic biomaterials should exhibit excellent biocompatibility, high corrosion resistance and low elastic modulus which are close to that of human bones. It was shown that in this sence Ti-Ta alloys have considerably better mechanical properties compared to pure titanium or tantalum [1, 2].
The main purpose of these experiments was investigation of possibility to induce interlayer mixing in an Ti/Ta immiscible multilayer system by laser irradiation.The absence of interlayer mixing was previously shown on this system during the Ar^+ ion irradiation up to relatively high fluence of $2x10^{16}$ ions cm^{-2} [3].
The system consisted of ten alternate Ti and Ta thin films (~18 nm each) and covered by slightly thicker Ti layer (~27 nm) on the top with the purpose of creating an appropriate porous structure very important for potential biocompatibility [4]. Structure was deposited on Si (100) wafers to a total thickness of 205 nm.
Laser irradiation was performed in air by picoseconds Nd: YAG laser. Defocused laser pulses had a laser spot on the sample surface of 3 mm in diameter and fluences of 0.057 and 0.11 J cm^{-2}. Laser beam was scanned over the 5x5 mm^2 surface area with different steps along y-axes to provide a variation in deposited energy density.
For structural and compositional characterisation following methods were used: Auger electron spectroscopy, X-ray photoelectron spectroscopy, atomic force microscopy and scanning electron microscopy.
The obtained results show that laser processing at a lower fluence causes only oxidation of the top Ti layer, invariable to the number of applied laser pulses and no interlayer mixing was observed. Appliance of laser pulses at fluence of 0.11 J cm^{-2}, on the other hand, caused significant increase of surface roughness and partial and/or complete ablation of deposited layers, but in partially ablated regions considerable mixing between Ti and Ta films was registered.
These experiments indicate that the use of picoseconds laser pulses with fluences in interval (0.057 – 0.11) J cm^{-2} could be very useful for mixing of titanium and tantalum layers and fabrication of a new material for medical implants. Suitable choice of films thicknesses would lead to the desired composition of this alloy.

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