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Investigation and Optimization on Surface Engineering NiTi Biomaterials

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The unique performance offerings of Ni-Ti alloys which involve the shape memory effect, super elasticity and biocompatibility have led to widespread acceptance of these alloys as valuable engineering materials. Particularly, more mature applications in the medical industry including medical devices such as, surgical instruments, implants for orthopedic applications, stents in cardiovascular diseases, in orthodontic applications. Deposition thin film of diamond like carbon by physical vapor methods. DLC had good characteristics as antibacterial property, low friction coefficient, high wear resistance and good corrosion resistance as in this dissertation. Two methods were applied as pulsed laser deposition and radio frequency sputtering with target of graphite.

Used two numbers of pulses as 300 and 600 in pulsed laser deposition process with different energies (200mJ, 400mJ, 600mJ) in vacuum medium with wave length 532nm of Nd: YAG laser. The other conditions of deposition were constant as the distance from the target to the substrate, the temperature of deposition, frequency, and pulse duration. Used three values of power as 200W, 400W, 600W in the radio frequency sputtering with other conditions were constant.

The phases of nitinol alloy as austenite B2 and martensite B19' and transformation temperatures were measured by X-ray diffraction and differential scanning calorimeter. The morphology and microstructure were observed by optical microscope, scanning electron microscope, atomic force microscope, Raman spectroscopy and electron dispersive spectroscopy. The measured properties were Vickers hardness ,wear rate , roughness. The corrosion rate and Ni release in Ringer solution as well as the toxicity by using Madian Darpy Canine Kidney cells were measured .

All deposited films in pulsed laser deposition were diamond like carbon depending on the peaks of Raman spectroscopy. The shape of the deposited film as islands in low pulses and energy. The increasing in pulses and energies led to appearance of clusters as demonstrated by SEM. Maximum value of Vickers hardness was 743 after 600pulses and 400mJ. Diamond like carbon behaved as tribofilm led to decrease the wear rate . The minimum wear rate after 600pulses and 600mJ was 1.4×10^{-8}g/cm with 93% as the percent of improvement and 0.25 as friction coefficient. The minimum corrosion rate was 0.0009mm/y after 600 pulses and 200mJ.The high percent of cell viability can be concluded after 600 pulses at 200mJ and 600mJ as 106% and 110% respectively.

The films after radio frequency sputtering were diamond like carbon. They appeared to be darker than the substrate with thickness constant for all powers as 150nm. Vickers hardness increased with increment in power. Ultimate value of hardness was 657 after 600W. The minimum value of wear rate was 2.3×10^{-8}g/cm after 200W with 87.8% as the improvement percent with 0.37 as friction coefficient. The largest value of cells alive in MTT at 400W as 93.11% with the lowest corrosion rate as 0.001mm/y.

In contemporary years, attracting to methods of soft computing because their ability to model and analyze complex problems. The genetic algorithm as an optimization method which arrange the constituents of the soft computing. A fuzzy inference system fashion the practice of formulating mapping from the input to an output using fuzzy logic. The Sugeno fuzzy model was suggested for a systematic approach to make fuzzy rules from a given data set of input and output. There were two programs by using MATLAB program. The first represented genetic algorithm with fuzzy inference system for radio frequency sputtering method. The second represented genetic algorithm with adaptive neuron fuzzy inference system for pulsed laser deposition. The optimized results were approximately near 300 pulses with 200mJ for pulsed laser deposition and 200W for radio frequency sputtering