PROCESS MAPPING OF LASER GLAZING AISI 316L STAINLESS STEEL FOR BIOMEDICAL IMPLANTS

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Due to limited lifetime for biomedical implants, material engineers have strived to improve the surface properties of existing biomaterials. Widely used methods of surface modification include film deposition such as physical vapour deposition (PVD), chemical vapour deposition (CVD) and diamond like carbon coating (DLC). Internal stresses make it difficult to bond such coatings to the substrates thus weakening the structure and limiting the life of implants. Laser glazing can achieve an amorphous layer on a component surface. Advantages of an amorphous layer include increased hardness, wear and corrosion resistance. These advantages arise from the elimination of crystalline anisotropy and inter-crystalline defects. These latter crystalline features provide the dislocation nucleation sites and shorter diffusion paths for enhanced oxidation and corrosion degradation. The current study introduced a surface modification method of laser glazing of biomedical AISI 316L austenitic stainless steel to improve tribological properties. This stainless steel is commonly used in orthopaedics owing to its high corrosion resistance. However, due to its low hardness (250 HV), its tribological properties are poor. A pulsed CO_2 laser was used with peak power and pulse width being varied between 0.4 to 1.5kW and 30µs to 120 µs respectively. The laser beam spot size, sample speed, percentage overlap and pulse repetition frequency were kept at 90µm, 570 rpm, 50% and 5 kHz respectively. These parameters were optimised from literature parameters using design of experiments software. This paper presents and discusses the effects of these processing parameters on the morphology of the glazed zone. Microstructure and chemical composition were determined by scanning electron microscopy (SEM), optical microscopy, and electron dispersive spectroscopy (EDS). X-ray diffraction (XRD) was used to analyse the degree of crystallinity in the glazed zone. A stylus profilometer and micro-hardness tester were also used to investigate the effects of glazing on roughness and hardness of the modified stainless steel layer. A strong correlation between irradiance, depth of processing and roughness of processed material was found. Increased depth of altered microstructure and increased roughness were linked to higher levels of irradiance.