UNIVERSITI TEKNOLOGI MARA

SURFACE ANALYSIS AND BIOCOMPATIBILITY OF TITANIUM ALLOY AFTER WIRE ELECTRO-DISCHARGE MACHINING (WEDM)

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MSc

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

The high demand of Ti-6Al-4V in medical industries becoming a concern nowadays. Titanium is a suitable material for orthopedic implants, dentistry and cardiovascular aids due to high resistance, immunity to corrosion, high fracture strength, osseointegration, low modulus and density. As the titanium is one of the most expensive materials and is categorised as a difficult-to-machine material, it is governed by the limitation of being machined through conventional machining. Hence, the problem in machining titanium can be solved by an alternative non-conventional machining process. A wire electro-discharge machining (WEDM) is able to machine the electrically conductive materials and with no physical contact between the workpiece and wire electrode which aids in keeping the material non-toxic for medical applications. The toxicity of the material has to be tested by way of biocompatibility testing. This research aims to develop the machining WEDM surface roughness prediction model through Artificial Neural Network (ANN), to characterise the machined surface of Ti-6Al-4V through WEDM and to determine the influences of machining processes on the biocompatibility of the machined part. The preliminary WEDM cutting operation helps in identifying the parameters and levels for the actual WEDM process. There are five phases in investigating the WEDM process of Ti-6Al-4V. Phase I is preliminary WEDM cutting operation, Phase II is mathematical prediction modelling on surface roughness by ANN, Phase III is sample preparation, Phase IV is machined surface observation and Phase V is cytotoxicity testing. In this study, three parameters which are pulse-off time, peak current and wire tension applied to WEDM process to achieve desired output performance. The experimental surface roughness is compared with predicted surface roughness using the Artificial Neural Network to optimise combination of parameters. It is found that, the lowest surface roughness (1.3770 µm) with minimum error percentage 0.5434 % obtained by the best combined parameters; 2 µs pulse-off time, 12 N wire tension and 10 A peak current. The pulse-off time is less significant on surface roughness observation. The effect of the machining process that is observed are the surface roughness, surface topography, elementary analysis and microhardness. The thickness of the white layer depends on the discharge energies at the gap between the wire electrode and the workpiece. The elements of Ti-6Al-4V maintained after the machining process. There are existence of zinc, carbon and oxygen that migrates from the workpiece and deionized water. The microhardness increased below the surface as the machined surface experiences thermal softening due to high temperatures. The biocompatibility of Ti-6Al-4V with L929 cells is based on the cell culture and cell viability testing showed 80% positive cell viability for each concentration of Ti-6Al-4V medium.

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