Grindability and Machinability of Cast Ti-Nb-Fe Alloys for Dental Applications

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ABSTRACT

In this study, the microstructure, mechanical properties, grindability and machinability of as-cast Ti-5Nb-xFe alloys with Fe content ranging from 1 to 5 wt.% prepared using a dental cast machine were investigated and compared with commercially pure titanium (c.p. Ti) and Ti-6Al-4V, which was used as a control. Experimental results indicated that the diffraction peaks of all the Ti-5Nb alloys have α' phase peaks. With 1,2,3 wt% Fe, metastable β phase starts to be retained. With Fe contents higher than 4 wt%, the equi-axed β phase is almost entirely retained. In addition, athermal ω phase was found in the Ti-5Nb-4Fe and Ti-5Nb-5Fe alloys. The largest quantity of ω phase and highest microhardness were found in Ti-5Nb-4Fe alloy. The grinding rate of the Ti-5Nb-xFe alloys showed a similar tendency with the microhardness. The grindability was evaluated by the volume of metal removed per minute (grinding rate) and the volume ratio of metal removed compared to the wheel material lost, calculated from the diameter loss (grinding ratio). The grindability of each metal was found to be largely dependent on the grinding conditions. The addition of Fe to Ti alloys did contribute to improving the grindability of c.p. Ti. The Ti-5Nb-xFe alloys with a higher Fe concentration could be ground more readily. The grinding rate of the Ti-5Nb-4Fe alloy at 1000 m/min was about 1.9 times higher than that of c.p. Ti.

Machinability was evaluated by the cutting forces, which traveled by the end mill to go from one edge of the specimen for permitted calculation of the average cutting forces for different metals. The experimental results indicated that the current cutting conditions, Ti-5Nb-xFe alloys and cp Ti than when the increase of Fe content when it's trend of cutting forces has increased dramatically to the Ti-5Nb-4Fe was reduced. The Ti-5Nb-xFe alloys with a higher Fe concentration could be cut more readily. Ti-5Nb-4Fe alloy at 110 m/min cutting speed, feed rate 30 mm/min, the cutting force is 5.09N. In addition, after adding cutting fluid will Ti-5Nb-xFe alloy cutting forces down 1~4N. The Ti-5Nb-4Fe alloy at 110 m/min cutting speed of the groove surface of the specimen, showing no adhesion of metal chips, and has the lowest surface roughness value (Ra).

Keywords : dental alloy、Ti-Nb alloys、microstructure、mechanical properties、grindability、machinability

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