Effect of Alloying Addition on Structure and Properties of Cast Ternary Titanium Alloys for Biomedical Applications

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ABSTRACT

The present work is a study of the structure and properties of TZX, TCX, TCFX alloy Phase / crystal structures, micro-structure, mechanical properties and grindability. to compare them with commercially pure titanium (c.p. Ti), which were cast using a dental titanium casting unit. TZX alloy aspects: Results were compared with c.p. Ti, which was chosen as a control. Results indicated that the phase/crystal structure, microstructure, mechanical properties and grindability of the TZ alloy can be significantly changed by adding small amounts of alloying elements. The alloying elements Nb, Mo, Cr and Fe contributed significantly to increasing the grinding ratio under all grinding conditions, although the grinding rate of all the metals was found to be largely dependent on grinding speed. The TZM alloy showed increases in microhardness (63%), bending strength (40%), bending modulus (30%) and elastic recovery angle (180%) over those of c.p. Ti, and was also found to have better grindability. The TZM alloy could therefore be used for prosthetic dental applications if other conditions necessary for dental casting are met. TCX alloy aspects: TC and TCX bending strength of the alloy are much higher than the c.p. Ti, in particular, TCN have the highest bending strength. Ternary Alloy bending elasticity modulus than c.p. Ti and TC alloy high, with TCZ alloys with the highest number of bending modulus. In addition, TC and TCX alloy also has more than c.p. Ti good elastic recovery capability. Therefore, the study of the TC and TCX alloy has good mechanical properties and its β phase of the structure will have a better alloy processing, and believe in the dental casting alloys with good will Potential applications. TCFX alloy aspects: The experimental results indicated that only TCF5 and TCF6 alloys exhibited ductile properties. The bending modulus of the TCF5 and TCF6 alloys without an ω phase were lower than those of the TC1 and TCFX alloys with an ω phase. The TCF5 alloy exhibited highest bending strength/modulus ratios as large as 25.1, being higher than those of commercially pure titanium (c.p. Ti) by 195% and of the TC1 alloy by 132%. Moreover, the TCF6 alloy also had highest ratios as large as 24.6, being higher than those of c.p. Ti by 189% and of the TC1 alloy by 128%. Furthermore, the elastically recoverable angles of the TCF5 (31.5 °) and TCF6 (29.6 °) alloys were greater than those of c.p. Ti (2.7 °) by as much as 1067% and 996%, respectively. The optical micrographs indicated that the surfaces of the TCF5 and TCF6 alloys were covered with many slip bands. In the current search for better implant materials, the low modulus, ductile property, excellent elastic recovery capability and reasonably high strength (or high strength/modulus ratio) β phase TCF5 and TCF6 alloys seem to be promising candidates. The largest quantity of ω phase and highest microhardness were found in TCF3 and TCF4 alloys. The grinding rates of the TC1 and TCFX alloys showed a similar tendency to the microhardness. The TC1, TCF2, TCF3 and TCF4 alloys exhibited the best grindability, especially at 500, 750 and 1000 m/min. Furthermore, the grindability of the tested metals increased in proportion to grinding speed up to 1000 m/min, with a decrease after 1200 m/min. This study concluded that Fe may be used to harden titanium and improve the grindability.

Keywords : Titanium alloy ; Dental alloy ; Structure ; Mechanical property ; ω phase ; Grindability

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