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Bi-modal particles effect on the microstructure, mechanical properties and corrosion behavior of Ti- nano composite for dental applications

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KEYWORDS

Powder Technology, Ti-12Mo/Al_2O_3 nano composite, Microstructure, Hardness, Corrosion resistance, Wear resistance, Dental applications.

SHORT SUMMARY

Titanium is reinforced with Mo, and Al2O3 bi-modal particles to fabricate Ti-12Mo/Al2O3 nano composite material suitable for dental applications. The powders are mixed by ball milling. 5, 10 & 15 wt.% nano alumina was added. Powder mixtures were compacted under 600 MPa and sintered in a vacuum furnace at 1450 oC. The microstructure and compositions were investigated by XRD and SEM. Al2O3 and Mo particles were homogeneously distributed in the Ti matrix. The density, Vickers hardness, wear resistance, and corrosion behavior in artificial saliva (AS) were investigated. By increasing Al2O3 content, the relative density was decreased. The hardness and wear resistance were improved monotonically with the increase of Al2O3 content. Better corrosion resistance was recorded. The concentrations of Ti, Mo and Al2O3 ions are extremely low in AS.

EXTENDED ABSTRACT

In the present study, a new composite material suitable for dental applications are successfully manufactured by powder metallurgy. Titanium matrix is hybrid reinforced with constant ratio of Mo, and different percentages of Al2O3 . The effect of the different weight percentages of Al2O3 on the properties of the Ti-12 % Mo composite was studied through a group of testes. The microstructure of sintered samples was examined by SEM, microscopy which showed a uniform distribution of the reinforcement material in the Ti-12%Mo matrix. XRD was also used for phase composition which indicated that peaks corresponding to Ti , Mo & Al2O3 are only recorded with no other peaks of any undesirable materials. Ti has Hcp crystal structure and Mo has BCC, while Al2O3 is a rhombohedral.

The relative density recorded a higher value for 12% Mo-free from Al2O3 sample that is was more than 99% Vickers hardness values recorded that addition of 12% Mo increases the hardness values from 320 to 440 Hv by 37.5% increments and 5% Al2O3 increase Hv from 440 to 594 by 35 %. Wear resistance were improved monotonically with the increase of Al2O3 content. The lowest wear rate value was recorded for 5% Al2O3 sample which was 0.05 mg/min. The corrosion behavior in artificial saliva (AS) were investigated. By increasing Al2O3 content, Better corrosion resistance was recorded. The concentrations of Ti, Mo and Al2O3 ions are extremely low in AS in which the Mo concentration was decreased to about 1.5 Mg/L