In-Vitro studies and corrosion behaviour of newly developed Ti–25Ta–25Nb–5Sn alloy for biomedical application

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Abstract

New material development for biomedical applications is a never-ending process to ensure biocompatibility, credibility, and economic viability. Among various biomedical applications, the beta titanium alloy holds its unique position in orthopaedic application due to its lower modulus than the other comparable alloys. Furthermore, among the various beta alloys, Ti-Ta-Nb alloys have better biocompatibility by eliminating conventional toxic beta stabilizers (i.e., Vanadium). In Ti-Ta-Nb alloys, the addition of Sn paved a path to eliminate double yielding phenomena of Ti-25Ta-25Nb alloys in Ti–25Ta–25Nb–3Sn alloy. Hence in this research article, the percentage of the Sn is increased to 5%, and its microstructural characterization, corresponding mechanical, and corrosion behaviour of a newly developed Ti–25Ta–25Nb–5Sn is reported. XRD analysis revealed the majority quantity of beta phase in the as-cast, homogenized and homogenized & quenched condition owing to the significant addition of beta stabilizers(i.e., Ta and Nb). The increase in the percentage of Sn had little or no influence on the stabilization of the beta phase, as the results were comparable to those observed in similar alloys (i.e., Ti-25-Ta-25Nb and Ti-25Ta25-Nb-3Sn). Compared to CP-Ti, a notable decrease of ~24% in Young's modulus (84 GPa) was observed in Ti–25Ta–25Nb–5Sn. However, the hardness of the Ti–25Ta–25Nb–5Sn (198 HV) was observed to be close with CP- Ti's hardness value (185HV). Nevertheless, a 36% increase in the hardness value was observed in Ti–25Ta–25Nb–5Sn compared to the Ti25Ta25Nb alloy. The corrosion behaviour of the Ti–25Ta–25Nb–5Sn is on par with the CP-Ti alloy. However, compared to the Ti-25Ta25-Nb-3Sn alloy, there was a notable decline in the corrosion behaviour of Ti–25Ta–25Nb–5Sn. This decline is probably attributed to the formation and distribution of oxides on the surface. Therefore, it can be concluded that, despite having an optimum point before the 5% Sn concentration, the Ti-25Ta25-Nb-5Sn alloy presents a set of properties superior to CP Ti. The Ti-25Ta25-Nb-5Sn alloy showed improved results during the short incubation time for in vitro tests performed with Adipose-Derived Stem Cells (ADSC). This alloy could be a favourable alternative to CP-Ti for biomedical applications.