Chapter 7

Conclusions

This thesis describes the synthesis of titanium metal ceramic matrix composites reinforced with two bioactive glasses S53P4 and 1393B3 bioactive glasses. The effect of reinforcing bioactive ceramic glasses in the TI metal matrix on its mechanical and biological properties is observed through series of characterization. Detail study is carried out on structural, mechanical, corrosion and biological properties of the various composites synthesis by powder metallurgical rout.

The literature review helpful to a guide about the synthesis, properties and characterziation of newly developed composites.

Among the several alloy systems, the three Ti alloy system Ti-Si-Mn, Ti-Nb-Fe,and Ti-Mo-Fe and two bioactive glasses 1393B3borate glass and S53P4 Silicate glasses are selected to form the following composites of varying concentration on the basis of their properties and reinforcing effect of ceramic glasses are analyzed on above mentioned properties.

1 .Ti-8Si-2Mn alloy matrix is reinforced with 1393B3 borate bioactive glasses .The composited are named as S1,S2,S3 and S4.

2. TI-8NB-2Fe alloy matrix is reinforced with S53P4 silicate bioactive glass. The composites are named as N1,N2,N3 and N4.

3.Ti-8Mo-2Fe alloy matrix is reinforced with S53P4 silicate bioactive glass.The composites are named as M1,M2,M3 and M4.

The important observations made on different aspects are listed at the end of the respective chapters and the major findings are summarized below

With the increased percentage of 1393 B3 bioactive glass, the porosity of composites increases and attain the value of 11% (S2), 15%(S3) and 22% (S4) due to the friction between glass and alloy particles at the interface which will be beneficial in the biological fixation and Osseointegration. The Hardness of pure alloy S1 (422 Hv) increases as compared to Ti-6Al-4V alloy. The samples, S3 and S4 exhibit the significant reduction in Young's modulus (76 and 68 Gpa) as compared to the reported modulus (110 Gpa) of Ti-6Al 4V alloy

The addition of bioactive glass 05% BAG (S2), 10%BAG (S3) and 20% BAG (S4) give the compressive strength of 323, 339 and 318 Mpa respectively which are superior to cortical bone. The cell culture including cytotoxicity and proliferation essay suggest that composite S1 and S3 are biocompatible and support the growth of the tumor cells at a lower concentration.

Pure Ti-8Nb-2Fe shows the compressive strength of 521 MPa while composite N2,N3 & N4 exhibit the compressive strength of 610,585 and 542 MPa which are superior to cortical bone. Due to the formation of intermetallic and intermediate compounds, the Hardness of pure alloy N1 as well as reinforced composite N2, N3 and N4 increases as compared to Ti-6Al-4V alloy and attains the value of 507,542,522 and 510 Hv respectively which are greater than the cortical bone also. Reinforcement of bioactive glass significantly reduces the elastic modulus of the composite and approaches the value of 81, 72 and 63 GPa in the N2, N3 and N4 samples which comes very close to that of cortical bones .

The formation of hydroxyl appetite layer in SBF in N3 and N4 composite have been observed prominent where the reinforcement percentage reaches 10% and 20% respectively.

The cell culture suggests that in all the composites, the bioactivity increases with the reinforced percentage of bioactive glass; however, the composite N4 is found to have maximum bioactivity. Among the composite N4 having 20% reinforcement of S53P4 bioactive glass comes out to be the best composition as it exhibits good biocompatibility, lowest elastic modulus (63 GPa), optimum compressive strength (542 MPa), enhanced bioactivity and increased hardness (510 Hv).

Composite M3 composite which is containing 10 % S53P4 bioactive glass in Ti-8Mo-2Fe alloy matrix seems to be well optimized composition because of considerably greater mechanical properties i.e. superior compressive strength ,low Young's modules, optimum density and hardness as compared to pre-existing Ti implants and more closely matched mechanical and biological properties with that of cortical bone.

So it can be proposed as a new novel load bearing bio implant which will potentially reduce the stress shielding effect, toxicity and will improve the Osseo conductivity.