Modification of structural and Mechanical properties of Bio-glass/ Tio2 Nano Composite scaffold with a Nano Composite coating based on PHB for Tissue engineering

Melika Rafiee, M.Sc; Dr Saeed Karbasi, Full Professor; Dr Mahboobeh Mahmoodi, Associate Professor

Azad University of Yazd

Introduction

- Bone defects and diseases have impacted the majority of the middle-aged population, which has led to develop a variety of methods to treat these disorders. Tissue Engineering is one of the advanced sciences, which has contributed to the treatment of these disorders. One of the biggest challenges for the engineers is to design a scaffold with suitable physical, mechanical and bioactive characteristics.

Materials and methods

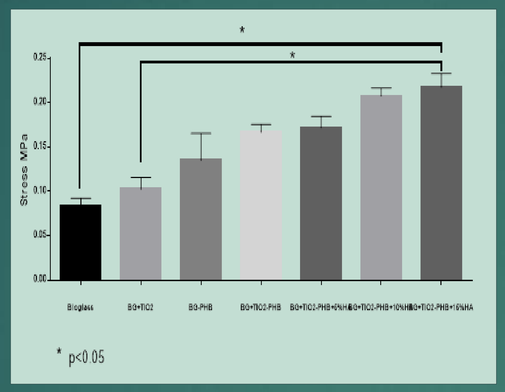
- In this thesis the design of a suitable scaffold for bone tissue engineering has been studied. First the Nano-bioglass powder was achieved by heating the pure ingredients in 1400 ˚C. Next the nBG/nTio2 composite scaffolds with 30 w% of nBG and 6 w% of nTiO2 were produced using the replication method. Then the scaffolds with 6 w% of P3HB and 5, 10 and 15 w% of Hydroxyapatite (HA) were coated for 30 seconds. Scaffolds physical properties were studied by using XRD, XRF, SEM and FTIR.

Result

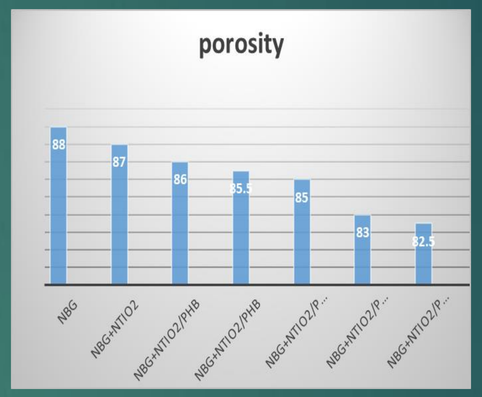
- The results demonstrated that it would be possible to achieve a scaffold with 82.5% porosity, 200-600 µm pore size and compressive strength of 0.08 - 0.21 MPa by using the replication method. It was concluded that the most optimized scaffold was consisted of 30 w% of nBG, 6 w% of nTiO2, 6 w% of P3HB and 15 w% of HA with 82.5% porosity and 0.21 MPa of compressive strength. At last, in order to evaluate the level of bioactivity of the scaffolds, they were kept in the simulated body fluid (SBF) in 37 ˚C in incubator for three weeks. The results from, SEM and ICP revealed the formation of HA on the scaffolds and therefore their enhanced bioactivity with nTiO2 and HA. This scaffold showed promising results and it can be used in bone tissue engineering.

Conclusion

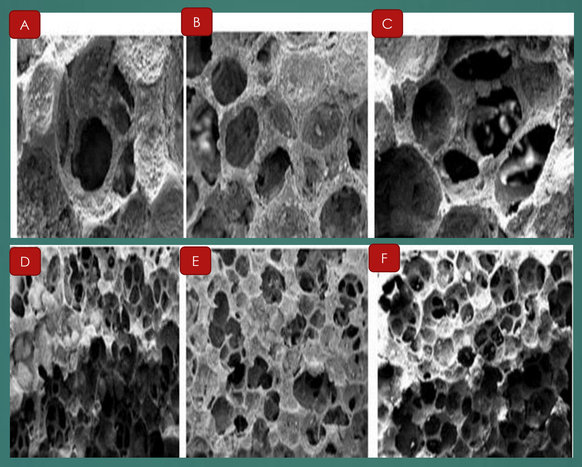
- The result of porosity and scaffold morphology showed that adding HA and P3HB composite to nBG/ nTio2 scaffold resulted decreasing in porosity, but the size, volume and interconnectivity of the proses were suitable. The result of mechanical test showed that adding HA and P3HB composite to nBG/Tio2 composite scaffold, increased compressive strength that is really important in bone tissue engineering. At last the result of bioactivity showed that adding HA/P3HB caused in significant increasing bioactivity on nBG/nTio2 Scaffold.



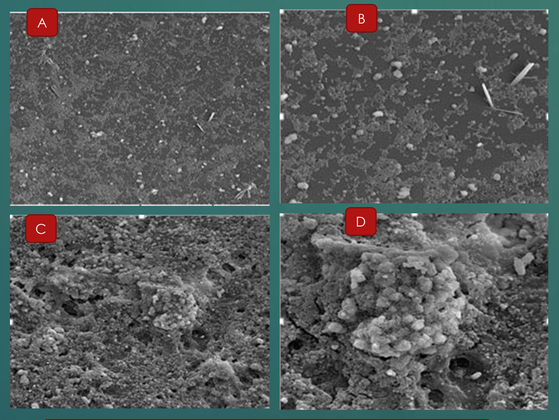
Compressive Strength of nBG, nBG/Tio2, nBG/ PHB, nBG + Tio2/ PHB, nBG/ Tio2/ PHB with 5%, 10% and 15%



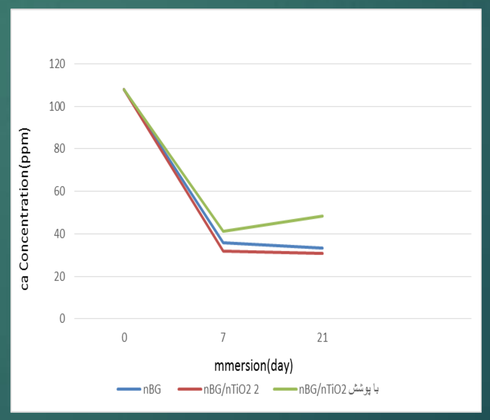
Porosity measurement of nBG, nBG/Tio2, nBG/ PHB, nBG + Tio2/ PHB, nBG/ Tio2/ PHB with 5%, 10% and 15%



SEM image of A)/D) nBG/ Tio2 +PHB/5% HA, B)/E) nBG/ nTio2+ PHB/10% HA, C)/F) nBG/ nTio2+ PHB/15% HA with 50X and 200X resolution



SEM Images of Composed HA on A) and B) nBG/ Tio2+PHB/15% HA after 7 days in SBF with 2000/ 5000 resolution and on C) and B) nBG/ Tio2+PHB/15% HA after 14 days in SBF with 2000/ 5000 resolution



Calcium Ion of nBG Scaffold and nBG / nTio2 Composite Scaffold With and without Coating