

Abstract

Bioceramics and bioglass ceramics are a wide arena of research in the current era due to their potential applications in orthopedics and surgery. In the present work, Glasses of novel composition $(50-x) \text{ CaO} - 34 \text{ SiO}_2 - 14.5 \text{ P}_2\text{O}_5 - 1 \text{ CaF}_2 - 0.5 \text{ MgF}_2 - x \text{ MgO}$ (% wt) (where $x=4, 25$ and 46) were synthesized by conventional melt-quench method. Each glass was sintered at different temperatures according to the endothermic and exothermic peaks of differential scanning calorimetric (DSC) data to form three glass ceramics named G1, G2 and G3 respectively. Crystalline phases of hydroxyapatite and wollastonite were observed in G1 and G2 whereas new phase of whitlockite was observed in G3 by X-Ray diffractometer (XRD) due to greater amount of MgO. Bulk properties of the samples were examined by studying density using Archimedes principle. Morphological study by scanning electron microscope (SEM) illustrated that the rate of densification increased with the decrease of CaO/MgO ratio. Bulk properties of the samples and morphological study by SEM revealed that rate of densification increased with the decrease of CaO/MgO ratio. Micro-hardness values (5192-6467 MPa) and bending strengths (211- 281 MPa) were found to be increased with increase of MgO in the composition and the results were in accordance to that of XRD, SEM and bulk density.

After investigating the structural and mechanical properties of the samples, *in-vitro* dissolution behavior of the same samples was investigated in conventional simulated body fluid (Kokubo's SBF-K9). Ionic concentration of SBF-K9 slightly varies from that of human blood plasma (less CO_3^- ions and high Cl^- ion). So it could be presumed that it could show slightly different results *in-vivo*. In order to avoid this situation and to clearly understand the behavior of G1, G2 and G3 in the *in-vivo* environment, bioactivity of the samples was further investigated in revised SBF (r-SBF) that has ionic concentration exactly equal to that of human blood plasma (HBP) and a comparative study of dissolution behavior of the samples, in SBF-K9 and r-SBF was performed. For that purpose, first, the stability of r-SBF and SBF-K9 was checked by observing the spontaneous precipitations on the surfaces of solutions, using atomic absorption spectroscopy and measuring the pH values, after respective days. Due to the

loss of stability of r-SBF after 25 days, we investigated the dissolution behavior of each sample in each solution upto 25 days. To perform the comparative study, thin film X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Scanning electron microscope (SEM), Energy dispersive spectroscopy (EDX), Atomic absorption spectroscopy (AAS) and pH meter were used. Thin film XRD analysis revealed the diffusive nature of the phases on the surfaces of samples after soaking for different time periods in r-SBF. It showed the poor precipitation and small thickness of the HCAp layer on the samples as compared to that in SBF-K9, thus indicating the fitness and sensitivity of r-SBF for *in-vitro* characterization of samples. AAS, FTIR and EDS revealed slow bonding rate on the surfaces of the samples in r-SBF than that in SBF-K9 that showed the dependence of bond formation on the composition of the materials as well as on the physiological fluid used for *in-vitro* characterization. The rate of HCAp formation was slower in r-SBF due to more competitive adsorption of CO_3^- ions to Ca and Mg ions owing to greater amount of CO_3^- in r-SBF than that in SBF-K9. It shows the importance of CO_3^- content in the physiological fluids for the *in-vitro* assessment of samples. Due to equal ionic concentration of HBP and r-SBF, assessment of samples in r-SBF could clearly indicate the exact timing of bond formation and behavior of samples *in-vivo*. So, r-SBF is recommended to be used for assessment of samples to clearly understand their behavior *in-vivo*.