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In-vitro and In-vivo Biocompatibility Evaluation of Silica Based Bio-active Glass Prepared by Hydrothermal Method

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Bioactive glass powders were synthesized by hydrothermal chemical route by the use of ultrasonic energy irradiation. We used sodalime, calcium nitrate tetra hydrate and di ammonium hydrogen phosphate as the precursor material to synthesize SiO_2 rich bio-active glass materials. The SiO_2 content was varied in the precursor mixture to 60, 52 and 45 mole%. Dense compacts were obtained by microwave sintering at 1,100°C. Mechanical properties were characterized for the fabricated dense bioactive glasses and were found to be comparable with conventional CaO-SiO_2-Na_2O-P_2O_5 bioactive glass. Detailed biocompatibility evaluation of the glass composition was investigated by in-vitro culture of MG-63 cell and mesenchyme stem cell. Cell adhesion behavior was investigated for both of the cell by one cell morphology for 30, 60 and 90 minutes. Cell proliferation behavior was investigated by culturing both of the cells for 1, 3 and 7 days and was found to be excellent. Both SEM and confocal laser scanning microscopy were used for the investigation. Western blot analysis was performed to evaluate the bimolecular level interaction and extent and rate of specific protein expression. The ability to form biological apatite in physiological condition was observed with simulated body fluid (SBF). In-vivo bone formation behavior was investigated after implanting the materials inside rabbit femur for 1 and 3 month. The bone formation behavior was excellent in all the bioglass compositions, specially the composition with 60% SiO2 content showed most promising trend.

Keywords: Bioactive glass, Biocompatibility, Hydrothermal method, In-vivo

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Fabrication and Characterization of the Ti-TCP Composite Biomaterials by Spark Plasma Sintering

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Ti metal has superior mechanical properties along with biocompatibility, but it still has the problem of bio-inertness thus forming weaker bond in bone/implant interface and long term clinical performance as orthopaedic and dental devices are restricted for stress shielding effect. On the other hand, despite the excellent biodegradable behavior as being an integral constituent of the natural bone, the mechanical properties of β-tricalcium phosphate ($Ca_3(PO_4)_2$; β-TCP) ceramics are not reliable enough for post operative load bearing application in human hard tissue defect site. One reasonable approach would be to mediate the features of the two by making a composite. In this study, β-TCP/Ti ceramic-metal composites were fabricated by spark plasma sintering in inert atmosphere to inhibit the formation of TiO_2. Composites of 30 vol%, 50 vol% and 70 vol% β-TCP with Ti were fabricated. Detailed microstructural and phase characteristics were investigated by FE-SEM, EDS and XRD. Material properties like relative density, hardness, compressive strength, elastic modulus etc. were characterized. Cell viability and biocompatibility were investigated using the MTT assay and by examining cell proliferation behavior.

Keywords: Ti, β-TCP, Biocompatibility, Bio-ceramic