Chapter II

Objective of the Work

Chapter II

Objective of the Work

The present work aims to reduce the fabrication cost of bioactive glass ceramic composites by using inexpensive metal salts instead of organometallics employing a mechanochemical route. A series of samples of the mixture of mechanochemically derived leucite/kalsilite and LTF in different weight ratios have been prepared to optimize the thermal, mechanical and microstructural properties. To further develop the bioactivity on leucite and kalsilite, a bioglass is introduced in the mechanochemically derived leucite and kalsilite abbreviated as bioactive glass-ceramics composites. The compositions which have optimum phase formation and better thermal, mechanical and microstructural properties among the series were investigated for the composite formulation. Al_2O_3 has been added to the mechanochemically derived leucite-based bioactive glass-ceramic composite to enhance the mechanical properties without affecting the biological and thermal response. Batch compositions were chosen to maintain the glossiness and bioactivity after addition of Al_2O_3.

The main objectives are as follows:

- To synthesize leucite/kalsilite by mechanochemical synthesis route and to prepare LTF, bioglass employing traditional melt quenching.
- To study the phase formation and crystal structure of the mechanically activated and heat treated leucite/kalsilite powders using X-ray diffraction.
- To prepare the bioactive glass-ceramic composites by mixing mechanochemically derived leucite/kalsilite with LTF and bioglass.

- To study the thermal expansion and surface morphology of the heat treated samples employing a dilatometer and scanning electron microscope respectively.
- To determine the flexural strength of the heat treated samples using the universal testing machine (UTM).
- To determine the concentration of ions (K^+, Na^+, Ca^{2+}) leaching of leucite and kalsilite in different acidic agents using a flame photometer.
- To study the cytocompatibility of the composites employing cell viability, cell proliferation, and In-vitro cytotoxicity assay of prepared materials and composites materials..

Statement of the Problem

The literature suggests that the introduction of bioactivity on dental ceramics results in a complete sealing of the marginal gap between the fixed prosthesis and the tooth. It consequently enhances the life of fixed restorations due to the elimination of secondary carries, micro penetration, and cement dissolution. Veneering Porcelain powders in more than sixteen shades are being marketed as a feldspar veneering ceramic for applying ceramic coatings on metal alloys in the conventional CTE (Coefficient of Thermal Expansion) range of metals alloys such as Ni/Co/Cr, high gold content, reduced gold content, palladium-based and non-precious metal alloys. These ceramic layers are bio inert presently and provide excellent bonding, stability, outstanding firing stability, milling and polishing properties. Coatings of these materials provide homogeneous and dense surfaces, similar to glass enamel like refraction and reflection behavior. The demand of porcelain fused metal restoration (PFM) in dentistry has increased the attention on low fusing leucite containing glass-ceramics because of its high thermal expansion coefficients. Matching of this property between metal and glass ceramics is the first need in these types of applications. Metal-ceramic restorations include denture teeth, crown, jacket, inlay, veneers and anterior bridges as a dental part. Keeping the above fact in mind the present research work was aimed to provide better bioactive ceramic materials for dentistry work, mainly for metal-ceramic restorations. In this aspect, leucite ($K_2O.Al_2O_3.2SiO_2$) phase enhances the CTE of glass-ceramic to make it thermally compatible with the metal. Leucite glass ceramics are processed by conventional route formed in a glassy matrix by nucleating and growing the leucite crystals with suitable heat treatments, but in this manner control of crystallinity and percentage of crystalline phase is very difficult. In this present research work, leucite/kalsilite based glass-ceramics and frit will be prepared separately. These prepared glass ceramics will be further added according to the required ratio in making composites for veneering ceramics containing bioactive glasses. In this way, content of high thermal expansion phases in glass-ceramic composites can be easily controlled. Preparation of leucite and kalsilite phases have been reported by different synthesis routes such as solid state sintering, co-precipitation, hydrothermal process and sol-gel method. It is also reported that a sol-gel derived leucite-based bioactive glass ceramic composites have excellent mechanical, thermal and biological properties. However, the disadvantage of the sol-gel synthesis is the high cost of the starting materials e.g. metal alkoxides.

In the present work to reduce the fabrication cost, mostly natural raw materials will be selected for experimental work and their impurities will be adjusted in the composition. Secondly, low-cost mechanochemical route will be implemented to obtain fine particle size distribution of starting materials to enhance their thermal reactivity. This synthesis technique is superior to both the solid-state sintering and wet chemical routes for the ceramic powder and produces fine particles up to nanometer range. It may be highlighted here that no such type of work is reported on the mechanochemically derived leucite/kalsilite based bioactive glass-ceramic composites. The prepared veneering dental materials in above manner will be further characterized for their mechanical, physical, chemical, thermal and biological properties.