CHAPTER 5

SUMMARY AND SUGGESTIONS FOR THE FUTURE WORK

5.1 SUMMARY

Polycrystalline tetragonal zirconia (TZP) ceramics are promising in many applications due to their high flexural strength, hardness and fracture toughness at room temperature or elevated temperature. Models for transformation toughening of zirconia predict that the toughness increases as the transformation zone height in the wake of the crack increases. In materials such as ceria-stablized tetragonal zirconia polycrystals, however, the transformation proceeds in an autocatalytic manner. This causes the transformation to spread unstably over macroscopic dimensions and the crack to follow the transformed microstructure to immediate failure. Extensive studies have been performed to improve the mechanical properties.

The present study reports the synthesis and characterization of pure zirconia and zirconia based ceramics by sol-gel process. The subject discussion of the thesis starts with an introduction to the structure of the zirconia, transformation toughening and various techniques used in the characterization of zirconia ceramics.

Thermal decomposition and phase evolution studies of dried gel powders of pure zirconia Y$_2$O$_3$-Zirconia, CeO$_2$-zirconia ceramics are discussed in detail by means of TGA, DTA analysis. For all the three samples, the gel
powders show three distinct temperature ranges of weight loss due to the evolution of volatiles present in the compound. The DTA curve shows the crystallization and transformation of the phases.

An X-ray diffraction study of the samples has been performed to confirm the crystallization behavior of pure zirconia Y-Zirconia and Ce-Zirconia ceramics. The crystallization begins at 700°C. Energy Dispersive X-ray analysis has been performed and the presence of the zirconia phase has been confirmed. The structural deformation and bonding nature of the powders heat treated at different temperatures has also been reported from FT-IR spectra.

Sintering behavior and microstructure has also been studied. The powder used for this study has been obtained by calcining the precursor gel at 1100°C for 6 hrs. The state of agglomerate and porosity has significant effect on sintered density behavior of dry and wet milled powders. Wet milled powders show a better sinterability than the dry milled powders. Particle size distribution studies show the wet milled powders have a better particle size distribution and range.

The mechanical properties such as hardness, fracture toughness and flexural strength of zirconia and zirconia based ceramics has also been determined. The Vicker's Hardness values show a maximum at 1350°C for various applied load. Fracture toughness and flexural strength also show increasing values for increasing sintering temperatures.
5.2 SUGGESTIONS FOR FUTURE WORK

Although the preparation and characterization of zirconia by sol-gel method improves the properties of these materials, many problems remain to be solved. The enhancement of sinterability of zirconia ceramics can be achieved by using ultrafine homogeneous powders rather than monophasic single-phase solution. To obtain better microstructure, the process can still be optimized to give better mechanical properties. Mechanical properties of various compositions of binary and ternary systems of this compound can be evaluated.

Thermal shock resistance and creep are the two important property studies, which will give us to understand the high temperature behavior of these materials. The electrical and thermal properties can also be studied. Suitability and functionality of these materials for structural and functional applications can be analyzed.