CHAPTER V

CONCLUSION

The present work describes the preparation of alumina-SiC nanocomposites by sol gel synthesis. The main highlights of the work include a process for obtaining alumina coatings on SiC particulates and their incorporation in alumina matrix for processing of composites, the influence of nucleating seeds and calcination conditions on densification and microstructure development of the composites and the mechanical property evaluation.

Thermal activation of as received SiC particles at 650°C for 30 min. result in oxidation at surfaces forming amorphous silica. This is then leached out by treating with hydrofluoric acid. Alumina coatings on ultra fine SiC particles are done by a controlled heterogeneous precipitation from aluminium nitrate salt solution. The conditions of coating are optimised to precipitate the desired boehmite phase at temperatures of 90°C and pH 7.5. The coated particles are characterised by FTIR, TEM, BET surface area and Zeta Potential measurements. It is shown that alumina coatings on SiC develop surface characteristics similar to the coating phase as evidenced by the change of iso electric point (IEP) from that of pure SiC to nearly that of alumina. Such precoated particles are shown to be effective dispersoids in processing of alumina-SiC nanocomposites.

Alumina-SiC nanocomposites were prepared involving boehmite sol and *in situ* coated SiC particles. Flocculation of boehmite sol containing coated particles
resulted in the formation of a gel network containing uniformly dispersed SiC particles due to the fact that they have same surface characteristics. A study on the dependence of calcination conditions on the sinterability of these precursors revealed that calcination of precursors at 1000°C resulted in a composition containing δ, θ transition aluminas along with α-alumina phase. Such precursors gave good sinterability attaining densities greater than 99% TD on sintering at 1700°C and is attributed to the enhanced diffusion rates of Al species present at that temperature of calcination.

The presence of α-alumina nucleating seeds facilitate not only an early transformation of the transition aluminas to α-alumina phase but also control the growth of α-alumina colonies producing an aggregate free structure. This enabled seeded composites to attain sintered densities greater than 99% TD compared to ~97% for the unseeded counterparts. Moreover, during the final stages of densification and grain growth a uniform grain boundary movement assisted by the pinning effects of homogeneously distributed SiC particles resulted in uniform, fine grained and dense microstructures in seeded composites. SiC particles are seen segregated at triple points on unseeded samples.

A comparison of the processing method with conventional solid state mixing routes has shown that sol gel processing has definite advantages with respect to dispersion characteristics of SiC in alumina. The sintered microstructures show individual SiC particles residing both at the grain boundaries and within grains. Partial agglomeration of SiC particles are observed in nanocomposites derived by powder mixing route.

There has been a significant difference on the role of MgO on densification and microstructure development in nanocomposite compared to monolithic alumina.
Formation of a low melting eutectic of protoenstatite, tridymite and cordierite at 1355°C create glassy phases leading to exaggerated grain growth in 1 wt% MgO doped nanocomposite. Grain sizes as high as 100μm was observed on sintering such samples at 1650°C.

Mechanical property evaluation of the composites show 25% increase in bending strength and 6% reduction in toughness compared to monolithic alumina. The observed increase in strength is attributed to the reduction in size and change in morphology of processing flaws compared to alumina where long columnar grains are considered detrimental to strength.

The present study involving the use of sol gel coated precursors for the processing of nanocomposites have resulted in excellent dispersion of SiC particles in a uniform fine grained alumina matrix and good mechanical properties. Utilisation of the present process avoid two costly steps namely the use of high purity ultra fine alumina powders as well as hot pressing which are very commonly used. Gas pressure sintering has been used to circumvent the limitations of hot pressing on size, shape and economic viability without compromising on the mechanical and microstructural features.