CHAPTER 7

CONCLUSIONS AND SUGGESTIONS FOR FURTHER WORK

The present work deals with the processing conditions, microstructure and electrical properties of PZT-PMN ceramics. Accordingly, the research contribution of this thesis has been made from the viewpoint of phase formation and transition, densification, microstructural development and dielectric response relationships.

7.1 Conclusions

Based on experimental results, the following conclusions have been reached:

(1) A new process has been developed for the preparation of single-phase perovskite PZT powders by employing a combination of simple mixed oxide synthetic route and a $ZrTiO_4$ precursor.

(2) High purity powders and ceramics of the perovskite *x*PZT-(1-*x*)PMN system have been successfully fabricated by employing a combination of the B-site precursor method and the pressureless sintering technique.

(3) A series of continuous solid solution of *x*PZT-(1-*x*)PMN perovskite structure, whose degree of tetragonality increased with increasing PZT concentration, was formed.

(4) Within the PZT-PMN solid solution series, there exists a morphotropic phase boundary (MPB) around 50-70 mol % of PZT concentration, separating tetragonal and (pseudo)cubic phases.

(5) The transition temperature (T_c), on the other hand, is insensitive to the grain size, which is similar to the observation in other similar system such as PMN-PT.[157]

(6) The dielectric properties are strongly influenced by the presence of secondary phases and densification mechanism which in turn depend on the processing parameters, i.e. purity, homogeneity and firing conditions. The observed characteristics of dielectric constant may be ultimately be governed by the factors that affect chemical composition, microstructural evolution and the processing relating to grain size, domain and grain boundaries.

7.2 Suggestions for Further Work

A number of interesting questions remain unanswered concerning the relationships between microstructural evolution and dielectric behaviour of the ceramics in the *x*PZT-(1-*x*)PMN system. Thus, it was anticipated that this could be partly filled by the following suggestions for further work.

(1) Loss of PbO content seem to be a major problem during the processing of *x*PZT-(1-*x*)PMN ceramics. Thus, the effects of sintering atmosphere and excess PbO on the densification, grain size and dielectric properties of PZT-PMN ceramics would need to be considered.

(2) Further investigation on the piezoelectric and electrostrictive measurements of these materials would provide knowledge and some baseline for

further electronic applications, and to see how they relate to the microstructural characteristics. In connection with this it is also of interest to point out that 0.7PZT-0.3PMN compositions appear to be promising candidate materials for further development to meet high dielectric constant devices such as capacitor applications.

(3) Further work on the microstructural characterization especially the domain and grain boundary characteristics of the materials in this study would facilitate a better understanding of complex perovskite ferroelectrics in general.