CHAPTER V

CONCLUSIONS

The 0.5 at% of La doped BNT and it's modified by Zr, Nb and Fe substitutions at B-site were performed by conventionally mixed-oxide method. The as-received oxide and carbonates were weighed as a stoicheometric fomula and milled by ball milling process for 24 H in acetone. After milling process, the slurry was then passing through suction and drying step. The optimum calcining process of all composition is 800°C for 2 h, because this condition pure perovskite phase could be obtained. The mixed oxide powders were then pressed into pellet and cold isostatic press (CIP) is used to obtain pellets of higher than 60% theoretical density. The Nb-BNLTs were sintered at 1050°C for 2 h. At higher sintering temperatures the single perovskite phase was decomposed into $Na_{0.5}Bi_{8.5}Ti_7O_{27}$ and Ti_6O_{11}. For Zr-BNLT and Fe-BNLT, the optimum sintering temperature was 1100°C for 2 h. The %relative theoretical densities of Zr-BNLT and Fe-BNLT were higher than 97% and those of Nb-BNLTs were 90-94%.

The lattice distances (a_R) of the Zr-BNLT compounds increased with an increase in the addition of zirconium substitutions which was the same as Nb-BNLT because Zr^{4+} and Nb^{5+} were associated with the larger ionic radius than Ti^{4+}which expanded the lattice distance. On the contrary, the Fe doped BNLT created the oxygen vacancies which shrinked the lattice distance.

It was observed that the average grain size of modified BNLT was significantly affected by the composition especially Fe and Nb doped BNLTs. The average grain size of Fe doped BNLT increases with increasing Fe concentration. The maximum of average grain size of Fe-BNLT was around 4 micron. The Zr concentration was not found to affect microstructure. The average grain size of Zr-BNLT was around 1 micron. The addition of Nb abnormally affected the grain size in reducing the average grain size from 1 micron to 0.3 micron, but the Nb concentration was insignificant to average grain size.

The Zr in BNLT system tremendously reduced the electrical resistivity due to its inability of incompletely poling. The modified-BNLT with an addition of 1.0 at% Fe provided the best of piezoelectric coefficient (d_{33}) of 155 pC/N and the planar (k_p) and thickness (k_t) electromechanical coupling factor of 16.6% and 46%, respectively.

Additionally, this provides an alternative piezoelectric ceramic to protect the environmental problems resulting from the use of lead-based compound.