Chapter 5

Summary and Conclusion

5.1 Summary of results

The results of these experiments were concluded as follows:

(A) Weight Loss and Density

1. Weight loss of $Ba_{1-x}Sr_xTiO_3$ solid solution when $0 \le x \le 0.3$ was less than 2% and weight loss of Pb doped $Ba_{0.8}Sr_{0.2}TiO_3$ was higher than 2%.

2. Density was approximately 96-97% for $Ba_{0.8}Sr_{0.2}TiO_3$ and 94-95% for 5-10%Pb doped $Ba_{0.8}Sr_{0.2}TiO_3$.

3. The weight loss increased with an increase of %Pb doped $Ba_{0.8}Sr_{0.2}TiO_3$.

(B) Microstructure

(B.1) Grain size

1. The addition of Sr up to 30% decreased the grain size of $BaTiO_3$.

2. The grain size of Pb doped $Ba_{0.8}Sr_{0.2}TiO_3$ was larger than that of undoped $Ba_{0.8}Sr_{0.2}TiO_3$.

3. Grain size of all compositions increased when the sintering temperature and soaking time increased.

(C) The Crystal Structure and Phase by XRD

1. BST with %Sr up to 10% had the tetragonal structure and Pb doped $Ba_{0.8}Sr_{0.2}TiO_3$ increased to 10% a cubic structure transform to the tetragonal structure.

2. XRD patterns of $Ba_{1-x}Sr_xTiO_3$ and Pb doped $Ba_{0.8}Sr_{0.2}TiO_3$ system showed only single phase.

3. The c/a ratio decreased as %Sr increased for $BaTiO_3$. In other word, the tetragonal structure tended to transform to a cubic as %Sr increased. In contrast, as %Pb increased for $Ba_{0.8}Sr_{0.2}TiO_3$ the c/a ratio increased so that the tetragonal structure was more stable. The c/a ratio effected to the Curie point.

(D) Dielectric Properties

1. k' depended on %Sr and %Ba, the trend of Curie temperature shifted to a lower temperature as %Sr increased as %Sr increased for BST system.

2. k' at room temperature of BST system increased as %Sr increased.

3. Doped with Pb, Ca or Zr maximum k' of BST decreased and also gave a broad phase transition.

4. For Pb doped BST, the Curie temperature of BST shifted to higher temperature but for Ca doped BST and Zr doped BST, it unchanged.

5. Maximum k' increased as %Pb increased up to 10% for $Ba_{0.8}Sr_{0.2}TiO_3$ system.

6. k' was also affected by sintering temperature and soaking time in which maximum k' increased as the sintering temperature and soaking time increased for undoped BST.

7. The dissipation factor depended on the composition, sintering temperature and measurement frequency for undoped and doped BST system. But it was nearly independent on soaking time.

8. The dissipation factor of $BaTiO_3$ decreased as %Sr increased up to 30% and further decreased as Pb was doped into $Ba_{0.8}Sr_{0.2}TiO_3$.

5.2 Conclusions

1. For undoped BST system, Sr can control grain growth.

2. The addition of Sr with less than 10% into $BaTiO_3$ exhibits a tetragonal structure.

3. The maximum dielectric constant of Sr doped $BaTiO_3$ is higher than that of undoped $BaTiO_3$.

4. Pb increases grain size of $Ba_{0.8}Sr_{0.2}TiO_3$.

5. The addition of Pb with more than 5% into $Ba_{0.8}Sr_{0.2}TiO_3$ exhibits a tetragonal structure.

6. Pb decreases the maximum dielectric constant and dissipation factor of $Ba_{0.8}Sr_{0.2}TiO_3$.

7. The Curie temperature shifts to a higher temperature as %Pb increases.

8. Higher density depending on sintering temperature and soaking time increases the dielectric constant and decreases the dissipation factor.

9. With Ca or Zr dopants, the maximum dielectric constant of $Ba_{0.8}Sr_{0.2}TiO_3$ is very lower as compared to undoped $Ba_{0.8}Sr_{0.2}TiO_3$.