CHAPTER 8

CONCLUSIONS

In this study, The PZT thin films were successfully fabricated using a triol sol-gel process. The fully crystallized perovskite phase of PZT without secondary phases was found in the film annealed at 600°C and the optimum excess Pb concentration is 10 wt% due to the best electrical properties could be achived. Optimization for fabrication condition of the new nanocomposite PZT-based thin films, i.e. PZT/WO_3 and PZT CuO is by deposition of the composite solutions onto a platinized substrate, and pre-heating at 400°C for 10 min. After that, a layer of PZT solution was deposited onto the former layer of the composite films and heated at 400°C for 10 min to infiltrate the pore or defect in the composite film, and then annealed at 600°C for 30 min. Phase evolution, microstructure, dielectric properties, ferroelectric properties and fatigue properties of PZT, PZT/WO_3 and PZT/CuO thin films were investigated. Based on experimental observation, the following conclusions have been reached.

1. Phase evolution of film was identified by X-ray diffraction method with a small angle technique. Results of X-ray diffraction for PZT/WO_3 films showed all films possessed a rhombohedral perovskite structure with the second phases of $PbWO_4$ and pyrochlore appearing at higher WO_3 added contents. The XRD data of phase identification for PZT/CuO thin films indicated that all films showed a crystalline

perovskite structure with the second phase appearing at higher CuO added contents (≥ 0.4 wt%). The second phase was matched with $Pb(Cu_2O_2)$ and pyrochlore. The changes of preferred orientation in the PZT/CuO films depended upon CuO added concentration.

2. Microstructure of PZT/WO_3 and PZT/CuO films were showed crack-free, dense, and equiaxed grains. The WO_3 addition reduced grain size of PZT film but the CuO addition promoted the grain growth of PZT films.

3. Dielectric and ferroelectric properties of the composite PZT films found to reduce when WO_3 or CuO were added. The PZT/WO_3 system showed donor doping by reduced coercive field and the optimum condition for this system is PZT/1wt% WO_3 films. While, the PZT/CuO system showed acceptor doping by increased coercive filed and the optimum condition for this system is PZT/0.2wt% CuO films. Thus these conditions were selected for further study on the effects of donor and acceptor doping on fatigue properties compared to pure PZT thin films.

4. Fatigue of composite PZT/WO_3 and PZT/CuO films was found to reduce compared to that of pure PZT film. The PZT/WO_3 (soft PZT) thin films showed a significant improvement in polarization fatigue compared to pure PZT and PZT/CuO (hard PZT) thin films. The improved fatigue behavior was also observed in the hard PZT, although the magnitude was smaller than that found in soft PZT. An oxygen vacancy is believed to play an important role in polarization degradation or fatigue.