Low-Temperature Sintered PZT-Based Ceramics and Their Applications on Actuators

謝政順、朱聖緣 ; 李中夏

E-mail: 8804787@mail.dyu.edu.tw

ABSTRACT

PZT-based ceramics, modified with Bi2O3, Fe2O3, CuO, MnO2 and Ba(Cu0.5W0.5)O3, were prepared by conventional mixed-oxide technique, with sintering temperature at 930℃ for 90 minutes. The dielectric constant measured at 1KHz is about 900 and the tangent loss is smaller than 0.1%. It has been shown that these additives were helpful in both lowing the sintering temperature and improving the dielectric properties. Microstructural and compositional analyses of the low-temperature sintered PZT-based ceramics have been carried out using XRD and SEM observation. We also successfully simulated the behavior of PZT-based piezoelectric transducers by utilizing the transmission-line-equivalent circuit model which based on Mason model and leach ’s controlled-source analogous models. The simulation results fit quite well with the experimental data, which will be very helpful in designing corresponding piezoelectric transducers. 0.25Pb(Ni1/3Nb2/3)O3-0.75Pb(Zr0.5Ti0.5)O3 (PNN-PZT) piezoceramics, doped and undoped with BiFeO3 and Ba(Cu0.5W0.5)O3 oxides, were then prepared by conventional mixed-oxide technique, using sintering temperature at 850°C ~ 950°C to obtain better piezoelectric/dielectric properties. Microstructural and compositional analyses of these low-temperature sintered PNN-PZT-based ceramics have been carried out using XRD and SEM. The effects of dopants on the sintering temperature and dielectric properties of the PNN-PZT ceramics have been investigated. In this paper, we successfully showed that these additives were helpful in both the lowing of the sintering temperature and the improvement of the dielectric properties. The sintering condition is also found.

Keywords : PZT-Based Ceramics ; Low-Temperature Sintered

Table of Contents

REFERENCES

1. B. Jaffe, W. Cook, Tr., and H. Jaffe, Piezoelectric Ceramics, Academic Press New York, 1971. 2. B. Jaffe, “ Piezoelectric Transducers Using lead Titanate and Lead Zirconate, ” U. S. Pat. 2, 708, 244 (1955). 3. B. Jaffe, “ morphotropic Piezoelectric Ceramics, ” U. S. Pat. 2, 849, 404 (1958). 4. F. Kulcsar, F. Park, and W. R. Cook, Jr., “ Piezoelectric Wave Filter Ceramics, ” U. S. Pat. 3, 179, 594 (1965). 5. A. Lungo, M. Heights, and D. E. Bonnemn, M. Heifhts, “ Lead Zirconate-Titanate Containing Manganese Additive, ” U. S. Pat. 3, 549, 536 (1970). 6. T. R. Shrout, B. Jones, J. V. Biggers, and J. H. Adair, “ Enhanced Processing of Peroskite Pb(Mg1/3Nb2/3)O3 Relaxors through Understanding the Surface Chemistry of the Component Powders, ” CERAMIC POWDER SCIENCE II, B, The American Ceramic-Society, Inc., p. 519-527, (1988). 7. J. P. Guha, and H. U. Auderson, “ Processing-Property Relations of Peroskite-Based Solide Solutions in the System Pb(Fe1/2Nb1/2)O3-Pb(Fe2/3W1/3)O3 ” CERAMIC POWDER SCIENCE III, The American Ceramics-Society, Inc., p. 709-716 (1990). 8. M. Lejeune, J. P. Boilot, “ Low Firing Dielectrics Base on Lead Magnesium Niobate, ” Mat. Res. Bull. Vol. 20, pp. 493-499 (1985). 9. D. Dong, M. Xiong, K. Murakami and S. Kaneko, “ Lowering of Sintering Temperature of Pb(Zr,Ti)O3 Ceramics by the Addition of BiFeO3 and Ba(Cu0.5W0.5)O3, ” Ferroelectrics, Vol. 145 p. 125-133 (1993). 10. A. J. Moulson and J. M. Herbert, “ Electrical Materials Properties Applications, ” Chapter 6, 1990. 11. B. Jaffe, W. R. Cook, and H. Jaffe, “ Piezoelectric Ceramics, ” p. 25. 12. W. P. mason edited, “ physical Acoustics, ” p. 194-5. 13. W. Marshall Leach, “ Controlled-Source Analogous Circuits and SPICE models for Piezoelectric Transducers, ” IEEE Trans. On Ultrasonics, Ferroelectrics and Frequency Control, Vol. 41, No. 1, p. 60-66, January (1994). 14. W. P. Mason, Electromechanical

Transducers and Wave Filter, Van Nostrand, Princeton (1948). 15. M. Redwood, J. Acoust. Soc. Am. 33, 527 (1961). 16. C. S. Hsieh, and J. M. Yan, C. H. Lee, S. L. Chen and S. Y. Chu, " The Analysis and Design of Low-Temperature Sintered PZT-Based Transducers Using PSPICE, " Proc. Of The 1998 Annual Conf. Of The Chinese Soc. For Mat. Sci. vol, K, p. 97-100. 17. C. S. Hsieh, and S. Y, Chu, " Doping Effects on The Piezoelectric Properties of Low Temperature Sintered PZT-based Ceramics, " Journal of Materials Science Letters., code 5459-99, it was accepted. 18. S. Kaneko, D. Dong, and K. Murakami, " Effect of Simultaneous Addition of BiFeO3 and Ba(Cu0.5W0.5)O3 on Lowing of Sintering Temperature of Pb(Zr,Ti)O3 Ceramics, " J. Am. Ceram. Soc., 81 [4] 1013-18 (1998). 19. C. S. Hsieh, and S. Y. Chu, " The Piezoelectric Properties of Low-Temperature Sintered PNN-PZT-Based Ceramics and Their Applications, " Integrated Ferroelectrics., it was accepted.