Solid State Science and Technology, Vol. 15, No 1 (2007) 74-81
ISSN 0128-7389
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PHASE STUDY AND ELECTRICAL PROPERTIES OF DIVALENT DOPED NON-STOICHIOMETRIC BISMUTH ZINC NIOBATE CUBIC PYROCHLORE

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ABSTRACT
A study of extrinsic doping is essential to elucidate relative ability of the pyrochlore materials to accommodate various dopants in forming new solid solutions and to search for improvement of electrical properties. Much reported stoichiometric cubic pyrochlore $Bi_3Zn_2Nb_3O_{14}$ appears to contain ZnO as secondary phase. Reducing Zn content in $Bi_3Zn_2Nb_3O_{14}$ resulted in $Bi_3Zn_{2-x}Nb_3O_{14-x}$ solid solutions where $0.04 < x < 0.31$. The phase pure material of composition $Bi_3Zn_{1.84}Nb_3O_{13.84}$ has been indexed on a cubic cell, space group FD3M, with cell constant a = 10.5579 (4) Å. Incorporation of divalent ions Cu^{2+}, Mg^{2+}, Ca^{2+}, Co^{2+}, Pb^{2+}, Cd^{2+} and Ni^{2+} in non-stoichiometric cubic pyrochlore $Bi_3Zn_{1.84}Nb_3O_{13.84}$ has been studied. Extensive solid solutions were observed when copper and cadmium were introduced as dopants where solid solution limits were obtained at x = 0.5 and 0.4, respectively in $Bi_3Zn_{1.84-x}Nb_3M_xO_{13.84}$. Other divalent dopants showed rather narrow solid solutions in the range of x = 0.15 to 0.25. Conductivity Arrhenius plots of all the doped materials are linear and reversible on heat-cool cycles with activation energy of 1.4-1.6 eV (x = 0.1). At the frequency of 100 kHz, these materials exhibit high relative permittivity (ε') and low dielectric loss (tan δ) with values in range of 50-100 and 0.001-0.015, respectively at 28 ^oC. A slight increase in relative permittivity was observed in the doped materials except where Cd^{2+} and Ni^{2+} were dopants. Dielectric loss generally increases with increasing dopant content. Copper doped solid solutions exhibit higher conductivity which could be associated with lowering of activation energy (1.4-0.8 eV).

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REFERENCES
[1]. Wang, X.L., Wang, H., and Yao, X. (1997); J. Am. Ceram. Soc. 80, 2745.
[2]. Levin, I., Amos, T.G., Nino, J.C., Vanderah, T.A., Randall, C.A., and Lanagan, M.T. (2002); J. Solid State Chem. 168, 69.
[3]. Levin, I., Amos, T.G., Nino, J.C., Vanderah, T.A., Reaney, I.M., Randall, C.A., and Lanagan, M.T. (2002); J. Mater. Res. 17, 1406
[4]. Mergen A., and Lee, W.H. (1997); Mater. Res. Bull 32, 175.
[5]. Subramanian, M.A., Aravamudan, G., and Subba Rao, G.V. (1983); Prog. Solid State Chem. 15, 56

[6]. Shannon, R.D. (1976); Acta Crystallogr. A32, 751
[7]. Tan, K.B., Lee, C.K., Zainal, Z., Miles, G.C. and West, A.R. (2005); J. Mater. Chem. 15, 3501
[8]. Liu, Y.P., Yao, X., and Zhang D.S., (2001); Ferroelectrics, 262, 59
[9]. Du, H.L., Yao, X., and Wang, H., (2001); Ferroelectrics, 262, 89
[10]. Liu, Y.P., Yao, X., Shen, B., and Zhang, L.Y. (2001); Ferroelectrics, 262, 65
[11]. Withers, R.L., Welberry, T.R., Larsson, A-K., Liu, Y., Norén, L., Rundlöf, H., and Brink, F. J. (2004); J. Solid State Chem. 177, 231
[12]. Nobre, M.A.L., and Lanfredi, S. (2001); Mater. Lett. 47, 362