

### P-051

**ORDERING STRUCTURE OF La AND Na MODIFIED  $Ba(Mg_{1/3}Nb_{2/3})O_3$  CERAMICS,** JONG HOO PAIK, S. NAHM, AND J. D. BYUN(Dept. of Mat. Scien. and Eng., Korea Univ., Seoul 136-701, Korea) H. J. LEE\*(New Material Evaluation Center, Korea Research Institute of Standards and science, Yusong, P.O. Box 102, Taejon, Korea)

The ordering behavior of  $Ba(Mg_{1/3}Nb_{2/3})O_3$  (BMN) ceramics modified by La and Na(or K) ions was investigated using X-ray diffraction pattern (XRD) and transmission electron microscopy (TEM). The 1:2 ordering found in BMN was transformed into 1:1 ordering with the La content and reached maximum values for  $(Ba_{1/2}La_{1/2})(Mg_{1/2}Nb_{1/2})O_3$ . For the BMN modified by the La and Na, 1:2 ordering structure was maintained. However, for the specimen sintered at high temperature, 1:2 ordered structure was transformed into disordered and 1:1 ordered structure.

### P-052

**THE EFFECT OF  $TiO_2$  AND  $SnO_2$  ON THE MICROWAVE DIELECTRIC PROPERTIES OF  $Ba(Mg_{1/3}Ta_{2/3})O_3$  CERAMICS,** CHANG HAK CHOI, S. NAHM, AND J. D. DONG(Dept. of Mat. Sci. and Eng., Korea Univ., Seoul, 136-701, Korea) M. H. KIM(Dept. of Mat. Sci. and Eng., Changwon National Univ., Changwon, 641-773, Korea)

$Ba(Mg_{1/3}Ta_{2/3})O_3$  (BMT) ceramics has attractive microwave dielectric properties. However, BMT is difficult to sinter. In this investigation, small amounts of  $TiO_2$  and  $SnO_2$  were added to improve the sinterability and Q-values. The maximum relative density of BMT was attained with 0.2 mol% addition of  $TiO_2$ (or  $SnO_2$ ). The degree of ordering, lattice distortion and microstructure were not significantly changed with the addition of  $TiO_2$ (or  $SnO_2$ ). However, with the addition of 0.2 mol%  $TiO_2$ (or  $SnO_2$ ), the Q-value was improved significantly.

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The microwave dielectric properties of  $BaTi_4O_9$  modified  $BaWO_3$  ceramic additions to glass and CuO have been investigated. The objective was to identify compositions in the the commercial glass system Ca-B-Si-Al-Mg and CuO that would lower sintering temperature of the dielectric in order to cofired with low loss conductors such as silver and gold. The sintering temperature of 1020°C can be realized for added to 5wt% glass and dielectric constant ( $\epsilon_r=31$ ) and quality factor ( $Q \times f_0 = 13,500$ ) obtained. The addition of CuO at the  $BaTi_4O_9 + BaWO_3$ , 3wt% + glass 5wt% considerably improved the low sintering temperature and does not remarkably affect the dielectric properties. A 1.0wt% addition of CuO gave the dielectric constant ( $\epsilon_r=32$ ) and quality factor ( $Q \times f_0 = 15,500$ ) at 950°C for 2 h sintering in air. Results of XRD analysis and scanning electron microscopy and the effect of the CuO content are also presented.

### P-054

**ELECTRICAL CONDUCTIVITY IN THE BROWNMILLERITE SYSTEM  $Ba_2(In_{1-x}M_x)_2O_3$  (M = Ga, Al),** H.YAMAMURA, H.HAMAZAKI and K.KAKINUMA, (Dept. Appl. Chem., Fac. of Eng., Kanagawa Univ. Yokohama 221 Japan), T. MORI and H. HANEDA (NIRIM, 1-1, Namiki, Tsukuba, 305 Japan)

The solid solution system  $Ba_2(In_{1-x}M_x)_2O_3$  (M=Ga,Al)( $0 \leq x \leq 0.5$ ) were prepared by a conventional ceramic technique, where the samples were sintered at 1400°C in air. While  $Ba_2In_2O_3$  showed orthorhombic brownmillerite phase, cubic perovskite phases were obtained in the composition range  $0.3 \leq x \leq 0.5$  and  $0.2 \leq x \leq 0.5$  for the Ga and the Al system, respectively. The electrical conductivity measured by DC 4 terminal method showed sharp increase around a phase transition temperature ( $T_d$ ) for the brownmillerite phase, and  $T_d$  shifted to lower temperature with increase in the composition, x. However, the conductivity of the samples with the cubic perovskite phase did not show such a sharp increase, and decreased with increase in the composition, x. The phase transition was also investigated by high temperature XRD.  $T_d$  values obtained by high temperature XRD were about 100°C higher than those obtained by the electrical conductivity. The difference of  $T_d$  values was discussed from a view point of ordering in tetrahedral site in cubic perovskite structure.