Can be the dielectric constant of thin films as-grown at room temperature higher than that of its bulk material?

Hyun June Jung, Chung Soo Kim*, Jeong Yong Lee*, Soon Gil Yoon†

Chungnam National University, Korea Advanced Institute of Science and Technology*

Abstract : The $Bi_2Mg_{2/3}Nb_{4/3}O_7$ (BMNO)-Bi composite films sandwiched by an Al_2O_3 protection layer exhibited a linear increase of a dielectric constant with increasing thickness and the 1000nm-thick BMNO-Bi composite films showed a dielectric constant (~220) higher than that of its bulk material (~210), keeping a low leakage current density of about 0.1μA/cm^2. An enhancement of the dielectric constant in the BMNO-Bi composite films was attributed to the hybrid model combined by a space charge polarization, dipolar response, and nano-capacitors. On the other hand, 1000nm-thick BMNO-Bi composite films sandwiched by 40nm-thick BMNO layer exhibited a dielectric constant of about 450 at 100 kHz and a leakage current density of 0.1μA/cm^2 at 6V.

Key Words : BMNO-Bi composite films, Al_2O_3, Dielectric constant, Leakage current density

1. Introduction

The dielectric behavior of ferroelectric-metal composites has attracted much attention due to the extraordinary dielectric enhancement.[1-3] The devices present optimal characteristics for use as a new type of ceramic capacitor when large charge-storage properties are required over a wide range of voltages, temperatures, and frequencies. As microsystems move to wards higher speed and miniaturization, the requirement of electronic components and devices grows consistently. The miniaturization especially becomes even more important today since more and more devices are required to be made portable.

2. Results and discussion

The BMNO-Bi composite films sandwiched by an Al_2O_3 protection layer exhibited a linear increase of a dielectric constant with increasing thickness and 1000nm-thick BMNO-Bi composite films showed a dielectric constant (~220) higher than that of its bulk material (~210). An enhancement of the dielectric constant in the BMNO-Bi composite films was attributed to the hybrid model combined by a space charge polarization, dipolar response, and nano-capacitors. On the other hand, 1000nm-thick BMNO-Bi composite filmss and wiched by 40nm-thick BMNO films exhibited a dielectric constant of about 450 at 100kHz and a leakage current density of 0.1μA/cm^2 at 6V. Higher dielectric constant than that of its bulk material was addressed in the BMNO films composited by a bismuth metal grown *in situ* at room temperature using a radio-frequency magnetron sputtering technique.

Acknowledgments

This work was funded by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government (MOST) (R01-2007-000-21017-0), by the KOSEF grant funded by the Korea Government (MEST) (No. 2009-0079164). This work is also the outcome of a Manpower Development Program for Energy & Resources supported by the Ministry of Knowledge and Economy (MKE), and was supported by the Brain Korea 21 Project in 2006

References

[1] C. Pecharromán, F. E. Betegón, J. F. Bartolomé, S. L. Esteban, and J. S. Moya, Adv. Mater. 13, 1541, 2001

[2] Z. M. Dang, C. W. Nan, D. Xie, Appl. Phys. Lett. 85, 97, 2004

[3] A. K. Jonscher, Nature 256, 566, 1975

† Corresponding author) Soon-Gil Yoon, e-mail: sgyoon@cnu.ac.kr,
Tel:042-821-3368, Address: Chungnam National University, Daeduk Science Town, 305-764, Daejeon, Korea