Sym. F : Ferroelectric Thin Films

DEVICE MATERIALS & SCIENCE

A-TUE-07

X-RAY PHOTOEMMITION SPECTROSCOPY MEASUREMENTS OF $SrBi_2Ta_2O_9$ AND $Bi_4Ti_3O_{12}$. B. H. PARK, S. J. HYUN, S. H. KANG, S. D. BU, and T. W. NOH (Dept. of Physics, Seoul National Univ., Seoul 151-742, Korea), T. H. KIM (LG Electronics Research Center, 16 Woomyeon-dong, Seocho-gu, Seoul 137-140, Korea)

It is well known that layered perovskite ferroelectric materials, such as $SrBi_2Ta_2O_9$ and $SrBi_2Nb_2O_9$ have fatigue-free properties. However, ferroelectric $Bi_4Ti_3O_{12}$ have showed fatigue failures although it has layered perovskite structure. We fabricated the epitaxial $SrBi_2Ta_2O_9$/Pt/MgO and $Bi_4Ti_3O_{12}$/Pt/MgO films in order to investigate the origin of the difference in fatigue behaviors. X-ray photoemission spectroscopy measurements were executed to compare the defects of the two materials. We analyzed the changes in Bi and Sr core levels of the two materials after 1 min sputtering. It was found that the $SrBi_2Ta_2O_9$ film contained oxygen vacancies only at the Bi_2O_2 layers and the $Bi_4Ti_3O_{12}$ film contained oxygen vacancies both at the Bi_2O_2 layers and in the perovskite structures. Therefore, we can suggest that the fatigue failure of the $Bi_4Ti_3O_{12}$ is due to the oxygen vacancies present in the perovskite structures. In order to find the fatigue mechanism of layered perovskite ferroelectric materials more systematically, we will investigate the new material, Bi_3TiTaO_9.

A-TUE-08

TWO-DIMENSIONAL SIMULATION OF FERRO-ELECTRIC MEMORY CELLS, K. DRAGOSITS, M. KNAIPP, and S. SELBERHERR (Inst.f.Microelectronics, Gusshausstr. 27-29, A-1040 Vienna, Austria)

For a rigorous analysis of the ferroelectric nonvolatile memory field effect transistor (FEMFET)[1] and similar devices a suitable model for the ferroelectric effects has been developed. Primary focus was laid on the simulation of field rotation. Therefore we assume a straight trajectory between the vectors of the old and the newly applied electric field. To calculate an operating point the former calculated polarization will be split into orthogonal components in respect to the direction of the next applied electric field. By means of these two components and the magnitude of the actually applied electric field a primary guess to the polarization is derived. Due to the vanishing electric field in the normal direction it is easier to switch the dipoles in this direction than the dipoles hold by the actual electric field. In respect to the available number of switching electric dipoles the orthogonal component is reduced appropriately. With calibration of simulations to measurements it is now possible to find effective material parameters for all devices using ferroelectric effects.

[1] S. L. Miller and P. J. McWhorter, "Physics of the Ferroelectric Nonvolatile Memory Field Effect Transistor," *J. of Appl. Phys.*, vol. 72, pp. 5999–6010, 1992.

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PROCESS INTEGRATION

A-TUE-09

RECENT DEVELOPMENTS IN FERROELECTRIC FILMS WITH LAYERED STRUCTURE Seshu B. Desu (Department of Electrical and Computer Engineering & Materials Science and Engineering, Virginia Tech, Blacksburg, VA 24061, U.S.A.)

Recently, ferroelectric thin films with layered structure (e.g., $SrBi_2Ta_2O_9$, SBT) have attracted considerable attention as one of the leading candidate materials for nonvolatile ferroelectric random access memories. However, one of the significant drawbacks of SBT is its high processing temperature (>750°C), which makes the selection of suitable barrier materials extremely difficult. Here we report on thin films of novel solid-solution material, $(1\text{-}X)SrBi_2Ta_2O_9\text{-}XBi_3TiTaO_9$, which can be processed at lower temperatures and exhibit better properties than those of SBT. The higher Pr and higher Tc and lower crystallization temperature of these thin films promise to solve many problems posed by SBT. For these solid solution films, it is possible to obtain a pyrochlore free crystalline phase at an annealing temperature of 600°C. The films exhibit good fatigue characteristics under bipolar stressing at least up to 10^{12} switching cycles and good memory retention characteristics.

A-TUE-10

ETCH CHARACTERISTICS OF FERROELECTRIC $SrBi_2Ta_2O_9$ THIN FILMS IN AN INDUCTIVELY COUPLED PLASMA

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Reactive ion etching of ferroelectric $SrBi_2Ta_2O_9$ (SBT) thin films has been studied using chlorine-based gases in an inductively coupled plasma (ICP). Etch rate and etch selectivity were investigated as a function of etch parameters including coil RF power, gas pressure, dc-bias voltage. In this study, etch rates of 600~1500Å were obtained depending on etch conditions. An study on etch damage and its recovery also made an attempt with Pt/SBT/Pt capacitor structure for the application to ferroelectric random access memory devices.