Construction and Characterization of (Y,Yb)MnO_3/HfO_2 Staking Layers for Application to FeRAM

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Key Words: ferroelectrics, insulator, thin film, chemical solution deposition, FeRAM,

Introduction

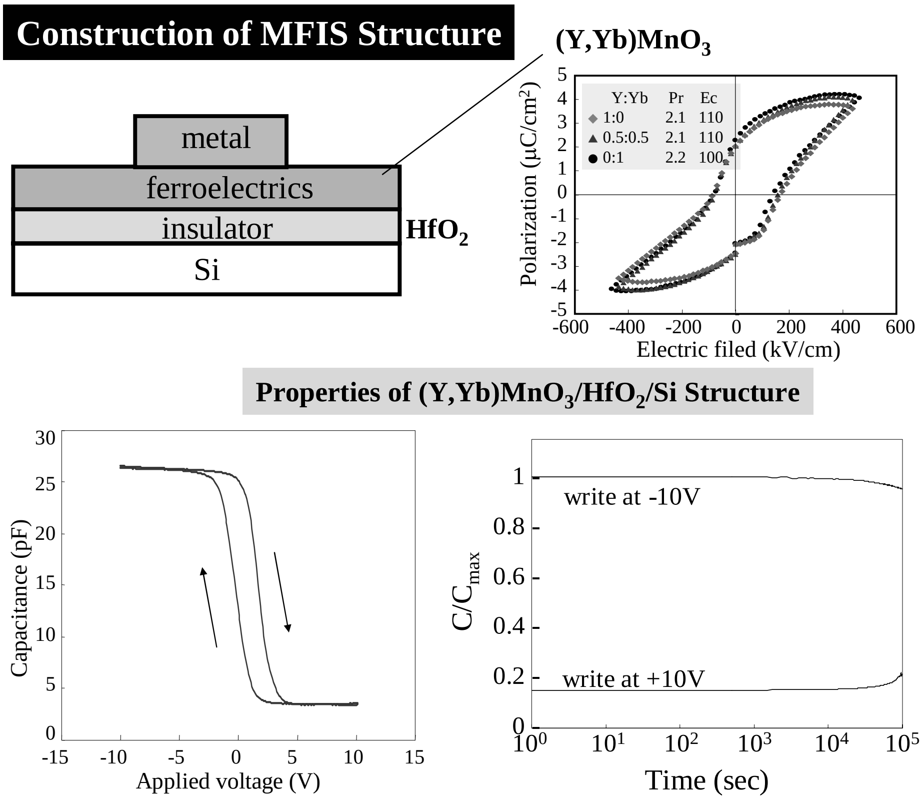
Recently, ferroelectric random access memories (FeRAM) have attracted much attention as a nonvolatile memory device. Particularly, field effect transistor (FET)-type memory has received great attention as next-generation memory because it has an advantage of high speed, low power consumption, reducing the memory cell size and nondestructive readout. $RMnO_3$ (R:Y, rare earth) with the hexagonal structure has been nominated for application of the FET-type nonvolatile memory because it has a low dielectric constant. In this paper, the (Y,Yb)MnO_3/HfO_2 stacking layer was constructed through the chemical solution process.

Experimental Procedure

HfO_2 insulating layers were prepared by spin coating Hf-based alkoxy-derived solutions. The as-deposited thin film was dried at 150ºC and calcined at 350ºC for 10 min in air. Then, the film was heated by rapid thermal annealing. For preparation of (Y,Yb)MnO_3 precursor solutions, yttrium iso-propoxide, ytterbium iso-propoxide and manganese iso-propoxide were selected as starting chemicals. (Y,Yb)MnO_3 films were prepared by spin coating the precursor solutions. The as-deposited films were dried at 150ºC and calcined at 350ºC for the 10min in air. Then, the films were heated by a rapid thermal annealing at 750ºC in argon.

Results and Discussion

For down-sizing the structure, lowering the operating voltage and improvement of the electrical properties, the controls of the film thickness, interface structure, orientation and crystallinity of the both insulating and ferroelectric films were necessary. The degree of c-axis orientation and crystallinity of the $Y_{0.5}Yb_{0.5}MnO_3$ films were improved on the 10nm-thick HfO_2 film deposited by using the diluted Hf-based solution. The electrical properties were improved in the MFIS structure with 10nm-thick insulating layer and 200nm-thick ferroelectric film. The clockwise C-V hysteresis induced by ferroelectric polarization switching was observed in the MFIS structures. The memory window of the MFIS using the improved HfO_2 thin layer was about 2V and the retention time was over 10^5s. The results of the alkoxy-derived MFIS structure would work for development of FET-type FeRAM devices.



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Field of Study
Ferroelectrics, Thin film, Chemical solution process, etc.