

Aging Properties of SBT Thin Films Prepared by RF Magnetron Sputtering Method

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Abstract : The Sr_{0.8}Bi_{2.2}Ta₂O₉(SBT)thin films are deposited on Pt-coated electrode(Pt/TiO₂/SiO₂/Si) using RF magnetron sputtering method. The aging properties of SBT capacitor with top electrodes represents a favorable properties in Pt electrode. The dielectric constant and leakage current density with Pt electrode is 340 and 6.81×10⁻¹⁰ A/cm² respectively. The maximum remanent polarization and the coercive electric field with Pt electrode are 12.40μC/cm² and 30kV/cm respectively.

Key Words : Sr_{0.8}Bi_{2.2}Ta₂O₉(SBT)thin film, aging propertie, Pt electrode, remanent polarization

1. INTRODUCTION

Numerous studies in recent years directed toward the development of nonvolatile memory using a thin ferroelectric film have been performed.[1]. The SBT film has so far been heat treated at temperatures as high as 800°C for 1 hour in oxygen atmosphere, which is more than 100°C higher than the 650°C at which PZT is heat treated. therefore lowering of the heat-treatment temperature for the SBT film is desired. Recently, some workers tried low-temperature formation of SBT films.[2-4] SBT thin films are knows to have a superior endurance property and a small coercive field after crystallization at high temperatures around 700-800°C.[5] However, such a high temperature process detrimentally affects the film quality, producing porous and rough structures with large grains.

In this paper, we report aging properties of SBT capacitors deposited on Pt-coated electrode(Pt/TiO₂/SiO₂/Si) substrate using RF magnetron sputtering method.

2. EXPERIMENT

The detailed sputtering conditions of SBT thin films are summarized in Table1.

Table 1. Sputtering condition of SBT thin films

sputtering condition	values
target	SBT(2 inch)
substrate	p-type Pt/TiO ₂ /SiO ₂ /Si(100)
base pressure	5×10 ⁻⁶ [Torr]
working pressure	2×10 ⁻² [Torr]
annealing temperature	650-800°C
Ar : O ₂	1 : 1
annealing time	30[min]

3. RESULTS AND DISCUSSIONS

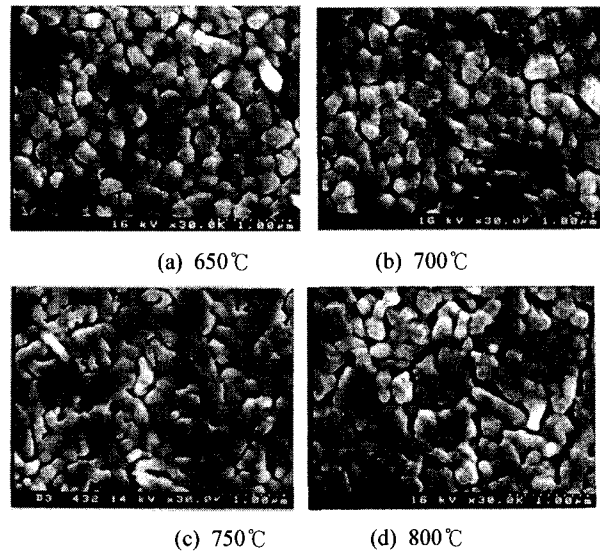


Photo. 1. SEM micrographs of SBT capacitor with annealing temperatures

As for a change in the micro structure of the SBT thin film depending upon the annealing temperature, it could be observed from the SEM image as shown in Photo. 1 that micro grains were shown in the thin film annealed at 650°C. In order to examine the crystal structure and the orientation depending upon the annealing temperature in the oxygen atmosphere, the XRD pattern was illustrated in Fig. 1.

Fig 2 shows the effect of top electrodes on the hysteresis loops when 5V was applied between the top and lower electrode. In the case of Pt electrode, there is the large remanent polarization than other electrodes.

4. CONCLUSION

The $\text{Sr}_{0.87}\text{Bi}_{1.26}\text{Ta}_2\text{O}_9$ (SBT) thin films are deposited on Pt-coated electrode (Pt/TiO₂/SiO₂/Si) using RF magnetron sputtering method. In the XRD pattern, the SBT thin films in all annealing temperatures had (105) orientation. In the SEM images, Bi-layered perovskite phase was crystallized at temperature of 750°C and grains largely grew in oxygen annealing atmosphere. The electrical properties of SBT capacitor with top electrodes represents a favorable properties in Pt electrode.

In the SBT thin film subsequently annealed in the oxygen atmosphere at 750°C, the most excellent characteristics were shown, and the remnant polarization (2P_r) value and the coercive electric field (E_c) were respectively about 12.40 μC/cm² and 30kV/cm. For the leakage current density and the dielectric constant of the SBT capacitor with Pt electrode annealed in the oxygen atmosphere showed the most excellent characteristic, and they were respectively about 2.13 × 10⁻⁹ A/cm² and 340.

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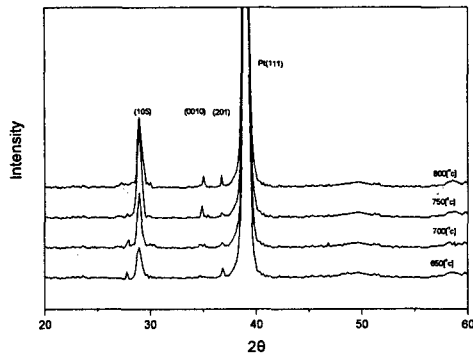


Fig. 1. X-ray patterns of SBT capacitors with annealing temperature in oxygen atmosphere.

Fig 3 shows a change in the leakage current density of the SBT capacitor with Pt electrode. When the annealing temperature was increased from 650°C to 750°C, the SBT capacitor showed the leakage current density value in the range of 10⁻⁹ to 10⁻⁷ [A/cm²] and the almost similar I-V characteristics.

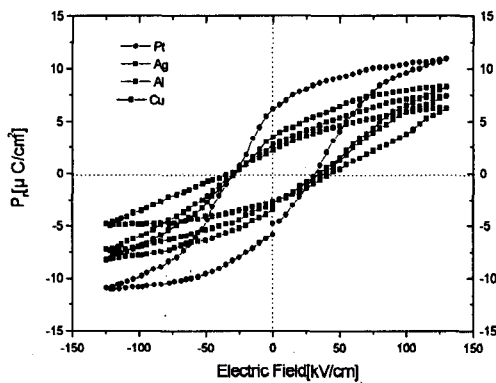


Fig. 2. P-E hysteresis loops of SBT capacitors with various annealing atmosphere

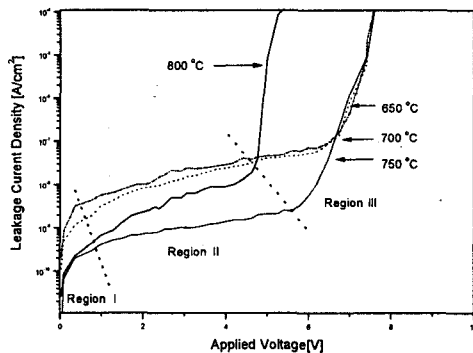


Fig. 3. Leakage current densities of SBT capacitors with annealing temperatures in oxygen atmosphere