ETCHING DAMAGE TO THE ELECTRICAL PROPETIES OF BLT THIN FILMS

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Plasma etching damage to Pt/BLT($Bi_{3.465}La_{0.85})Ti_{3.0}O_{12}$ /Pt ferroelectric capacitors was evaluated under Ar bombardment and CHF_3 etch plasmas. And the surface composition of etched BLT was evaluated under Ar/CF_4 and Ar/CHF_3 etch plasmas by XPS. The hysteresis properties and leakage current were examined to study the effects of damage. The damage effects were found to be dependent on etching gas. The electrical properties of the etched Pt/BLT/Pt capacitor were substantially recovered by annealing at 700℃ for 20min.

The capacitor area for the MFM structure was 100×100 ㎛^{2}. The physical thickness of BLT thin film was 2000Å. The hysteresis curve and current-voltage (I-V) were measured using RT66A and HP4145B semiconductor parameter analyzer, respectively. Samples were etched at the condition of working pressure of 5mTorr, source power of 800W, and bias power of 300W by using a helicon plasma etcher.

Figure 1 shows the surface compositional variation of BLT thin films as a function of etch gas condition. The relative atomic ratio of oxygen and bismuth decreases much more than those of lanthanum and titanium in all etching conditions. This is due to that oxygen and bismuth are more volatile than lanthanum and titanium. Among etching conditions, the atomic ratio of oxygen at the condition of Ar/CHF_3=80/20 plasma is higher. This condition may suggest the possibility of preserving the initial electrical properties of BLT capacitor. Figure 2 shows the hysteresis properties of recovered and etched BLT capacitors in Ar/CHF_3=80/20 plasmas. BLT capacitor has a remanent polarization of about 12μC/cm^2 after etching and of about 14μC/cm^2 after recovery annealing. And the relative voltage shift is also found after etching and results in asymmetrical hysteresis loop, which is due to positive ion bombardment at the top electrode[1]. After annealing the hysteresis loop has a symmetrical loop. As shown in Fig.1, the etched BLT capacitor is less damaged relatively and recovered completely[1,2]. Figure 2 shows the I-V curves of of recovered and etched BLT capacitors in Ar/CHF_3=80/20 plasmas. The leakage current density of etched sample shows the relative low value of scores of 10^{-7}A/cm^2. Recovered sample also shows the leakage current density of the range of 10^{-7}A/cm^2.

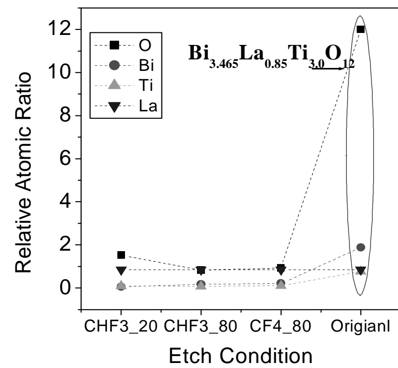

Fig. 1 Surface compositional variation of BLT thin films as a function of etch gas condition. (CHF3_20: Ar/CHF_3=80/20, CHF3_80: Ar/CHF_3=20/80, Ar/CF_4=20/ 80sccm, and Original: $(Bi_{3.465}La_{0.85})Ti_{3.0}O_{12}$ not etched).

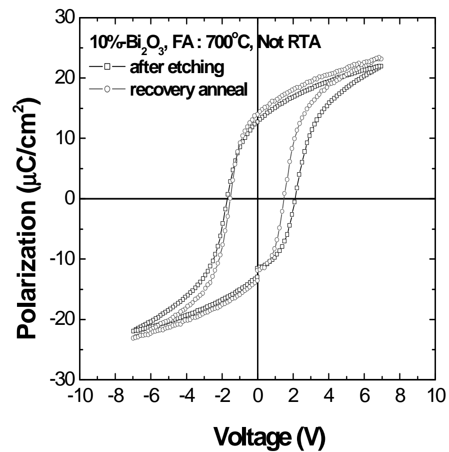

Fig. 2 Hysteresis properties of recovered and etched BLT capacitors in in Ar/CHF_3=80/20 plasmas.

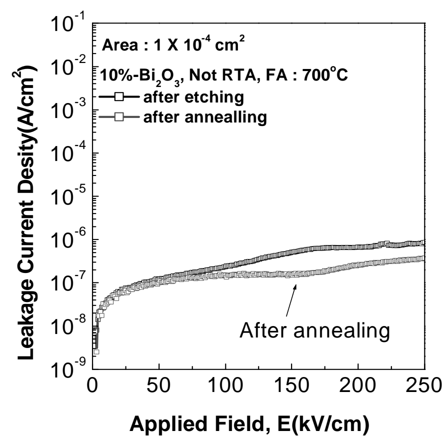

Fig. 3 Current-voltage curve of recovered and etched BLT capacitors in in Ar/CHF_3=80/20 plasmas.

References

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