Electrical characteristics of ferroelectric undoped HfO_2 directly deposited on Si(100) utilizing Kr/O_2 sputtering

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1. Introduction

In order to realize ferroelectric field-effect transistors (FeFETs), the growth of metastable orthorhombic HfO_2 on Si substrates is necessary.

Utilizing Ar/O_2 sputtering, we obtained the memory window (MW) of 0.84 V from the C-V characteristics for the undoped HfO_2 directly deposited on p-Si(100) [1,2]. However, there was a stretch in the C-V curves at accumulation region, which indicated the existence of interface traps between HfO_2 and Si.

In this research, the ferroelectric properties of undoped HfO_2 directly deposited on Si substrates utilizing Kr/O_2 sputtering were investigated.

2. Experimental Procedure

The p-Si(100) substrates (10-30 Ωcm) were cleaned by SPM (H_2SO_4:H_2O_2 = 4:1) and DHF (HF:H_2O = 1:100) followed by the ultra-pure water rinse. Then, HfO_2 films were deposited by RF magnetron sputtering at room temperature with the sputtering power of 100 W. The Ar/O_2[1] and Kr/O_2 flow ratio were 2.0/0.2 sccm and 1.0/0.2 sccm, respectively. The thickness was 20 nm and the gas pressure was 0.35 Pa. Then, post deposition annealing was carried out at 600 °C for 30 s in N_2 ambient. Finally, Al electrode was evaporated. The fabricated MFS diodes were evaluated by C-V and J-V.

3. Results and Discussion

C-V characteristics of Al/HfO_2/p-Si(100) utilizing Ar/O_2 sputtering and Kr/O_2 sputtering were shown in Fig. 1(a). We found that the stretch in the C-V curves measured at 100 kHz was decreased by the Kr/O_2 sputtering. The MW was increased from 0.5 V for Ar/O_2 sputtering to 0.7 V for Kr/O_2 sputtering, which indicates that ferroelectric properties were improved by Kr/O_2 sputtering. The leakage current for the diodes was on the order of 10^{-8} A/cm^2 at V_G = -5 V, while it increased to 10^{-6} A/cm^2 at V_G = +5 V as shown in Fig. 1(b).

4. Conclusions

We investigated the ferroelectric undoped HfO_2 directly deposited on Si(100). It was found that Kr/O_2 sputtering improved the electrical characteristics of ferroelectric undoped HfO_2.

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References

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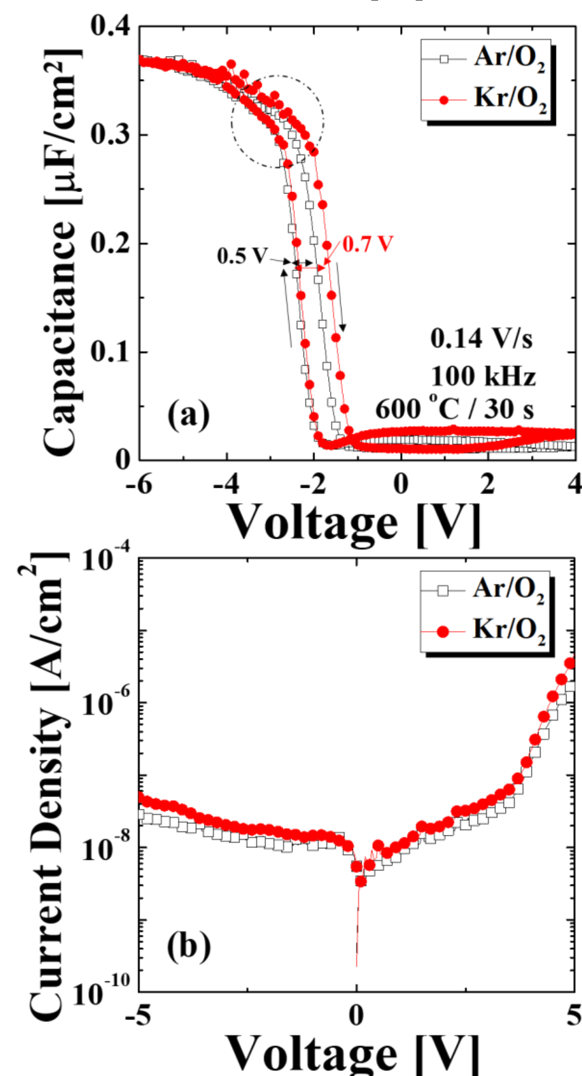

Figure 1 Comparison of (a) C-V and (b) J-V characteristics of Al/HfO_2/Si(100) diodes.

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