The effect of sputtering power for Pt gate electrode deposition on the ferroelectric property of 5 nm thick undoped HfO_2

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1. Introduction

The ferroelectric HfO_2 is widely investigated due to its Si CMOS compatibility and scalability [1]. Previously, we have reported the ferroelectricity of 5 nm thick undoped HfO_2 formed on Si(100) by Kr/O_2 plasma sputtering with Pt gate electrode [2]. However, the improvement of sputtering damage is still issue for ultrathin ferroelectric HfO_2.

In this research, we investigated the influence of sputtering power for Pt gate electrode deposition to improve the ferroelectricity of 5 nm thick undoped HfO_2 formation.

2. Experimental procedure

Ferroelectric 5 nm thick HfO_2 films were directly deposited on p-Si(100) and p^+-Si(100) substrates at room temperature (RT) by utilizing RF magnetron sputtering with Hf target. Kr/O_2 gas flow ratio of 2.0/0.2 sccm, the gas pressure of 0.67 Pa, and the sputtering power of 60 W were used for the ferroelectric HfO_2 formation. Subsequently, Pt gate electrodes were in-situ deposited by RF magnetron sputtering. The sputtering power for Pt deposition was changed from 30 to 80 W. Pt gate electrodes were wet etched by aqua regia, and the electrode size was 30×30 μm^2. Then, post-metallization annealing (PMA) process was carried out at 500 °C/30 s in N_2 ambient. Finally, Al electrode was evaporated on the back side of substrate. The electrical characteristics of the fabricated $Pt/HfO_2/Si/Al$ diodes were characterized by C-V, J-V and P-V measurements.

3. Results and Discussion

Figure 1(a) shows the density of interface states (D_{it}) and current density at the gate voltage (V_G) of -1.5 V as the sputtering power for Pt electrode deposition was changed. The lowest leakage current of 3×10^{-8} A/cm^2 was observed in case of 40 W. This is probably because of the improvement of interface property with the smallest D_{it} as 1.8×10^{12} cm^{-2}eV^{-1} by the sputtering power of 40 W. Comparing with remnant polarization ($2P_r$) of 10 nm thick HfO_2 as 2.5 μC/cm^2, the ferroelectric property of 5 nm thick HfO_2 in Fig. 1(b) was improved with the largest $2P_r$ of 3.8 μC/cm^2 at the frequency of 10 kHz due to the suppression of charge injection phenomenon in case of 40 W [2].

4. Conclusions

In this paper, the effect of sputtering power for Pt gate electrode deposition was investigated. Low sputtering power of 40 W for Pt electrode deposition was effective to improve the ferroelectricity of 5 nm thick undoped HfO_2.

Acknowledgements

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References

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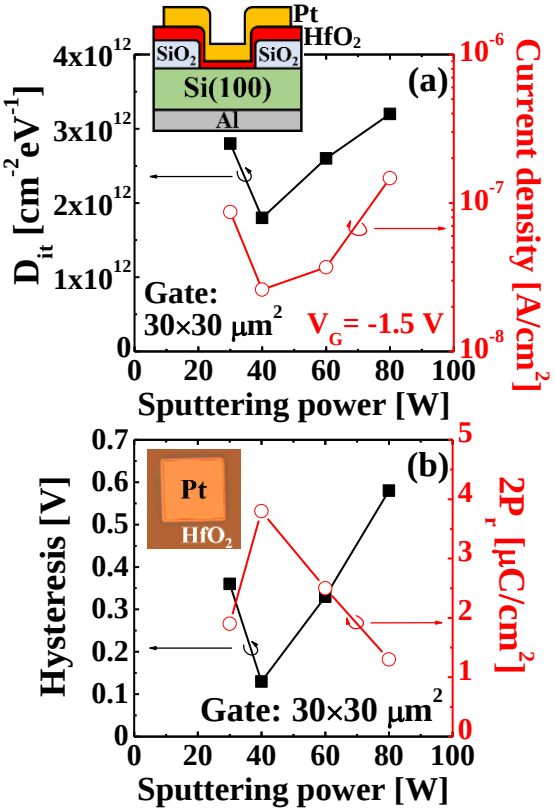

Figure 1. (a) D_{it} and leakage current at V_G of -1.5 V and (b) hysteresis and $2P_r$ as the sputtering power for Pt electrode deposition was changed from 30 to 100 W.