The effect of post metallization annealing sequence on the Pt gate etching immunity of MFSFET with ferroelectric non-doped HfO_2

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1．Introduction

The ferroelectric HfO_2 is widely investigated due to its Si CMOS compatibility and scalability [1], the application for metal ferroelectric semiconductor field effect transistor (MFSFET) is also highly expected. We have previously reported the characteristics of MFSFET with 5nm ferroelectric non-doped HfO_2 [2]. However, the wet etching damage of Pt gate is still issue in case of the etching for as-deposited Pt/HfO_2 stacked layers.

In this research, we investigated the post metallization annealing (PMA) procedure to optimize the wet etching process.

2．Experimental procedure

The 100 nm thick field oxide was formed on the p-Si(100) substrate, then the channel stop and source/drain region was formed by ion implantation. Next, 5 nm thick HfO_2 and 20 nm Pt were deposited in-situ at room temperature by RF magnetron sputtering. The Ar/O_2 flow ratio and sputter power of HfO_2 were Ar/O_2=3.0/0.2 sccm and 60 W. Then, the PMA of 500 °C/30 s in N_2 ambient was carried out before the patterning of Pt electrode to compare with conventional process. Finally, Al electrode was evaporated on the back side of substrate. The I_D-V_G characteristics were evaluated for the fabricated devices.

3. Results and Discussion

Figure 2 shows the effect of wet etching procedure on the I_D-V_G characteristics of the MFSFETs. Although charge injection type hysteresis was observed, the device fabricated by PMA before Pt etching is smaller. Furthermore, off leakage current was decreased as 2 orders of magnitude because of the improvement of wet etching immunity of HfO_2 film.

4．Conclusions

In this paper, the effect of PMA sequence for MFSFET with 5 nm thick ferroelectric non-doped HfO_2 was investigated. PMA before wet etching process was effective to reduce the wet etching damage to HfO_2 thin film and improve the device characteristics.

Acknowledgement

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References

[1] Z. Fan *et al.*, J. Adv. Dielectr., **6**, 1630003 (2016).

[2] M. Tanuma *et al.*, 2022 AWAD, B5-4 (2022).

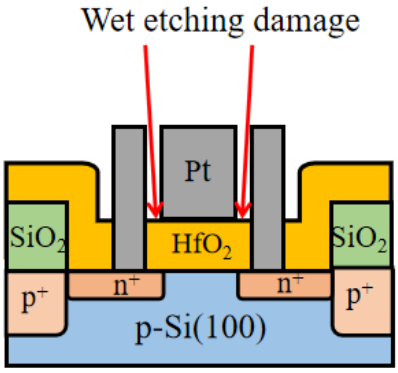

Figure 1. Cross-section schematic of device indicates the etching damage region.

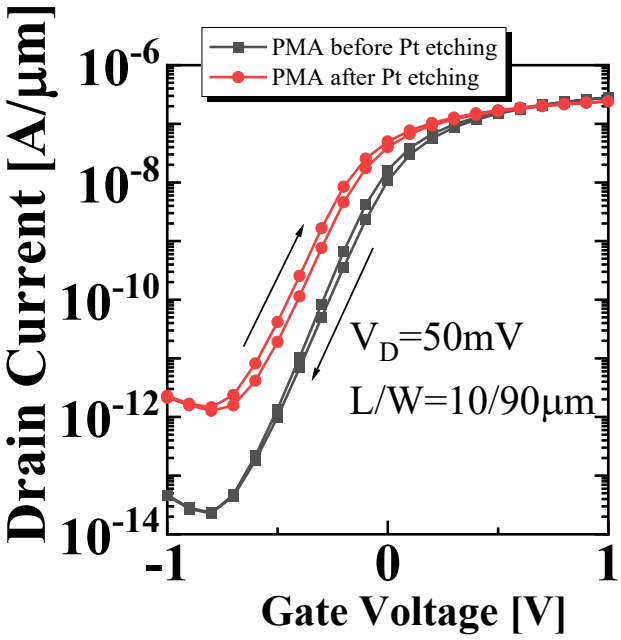

Figure 2. I_D-V_G characteristics of two different PMA sequences.