

Lateral etching of HfN_{0.5} narrow line utilizing diluted HF solution

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1. Introduction

The so-called high- κ gate dielectrics are regarded as the most promising candidates to overcome the limitations of transistor scaling [1], such as equivalent-oxide-thickness (EOT) and gate length (L_g) scaling. We have reported that 0.5 nm EOT utilizing bilayer HfN_x gate insulators with in-situ formed HfN_{0.5} gate electrode [2]. In this paper, the lateral etching of HfN_{0.5} gate electrode utilizing diluted HF (DHF) solution was investigated.

2. Experimental Procedures

The p-Si (100) substrates were cleaned using SPM and DHF followed by the ultra-pure water rinse. Then, the 18-nm-thick HfN_{0.5} film was deposited utilizing ECR plasma sputtering at room temperature (RT) with Ar/N₂ gas flow ratio of 10/0.2 sccm, microwave power of 500 W and RF power of 400 W. After that, 4 μ m line-and-space (L/S) was patterned, followed by the DHF (HF:H₂O = 1:100) wet etching for 0 to 195 s. Finally, the lateral etching rate was evaluated by optical microscopy.

3. Results and Discussion

Figure 1 shows the top-view of 4 μ m L/S after etching and removal of photoresist (PR). The 18-nm-thick HfN_{0.5} film could be completely etched in vertical direction by 20 s etching. Lateral etched length and etched line width dependent on the etching duration was extracted from L/S patterns as shown in Fig. 2. The variation of line width was approximately 150 nm after 195 s etching. The lateral etching rate was 1.1 μ m/min which is corresponding to the slope of the plots in Fig. 2. The lateral etching seemed to be initiated with the incubation time below 120 s as shown in Fig. 2.

4. Conclusion

The lateral etching of HfN_{0.5} film was investigated utilizing DHF. As a conclusion, the precise control of lateral etching for HfN_{0.5} gate electrode was realized which would be suitable for narrow gate formation.

5. Acknowledgement

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6. References

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- [2] N. Atthi *et al.*, *IEICE Electron. Exp.* **13**, 20160054 (2016).

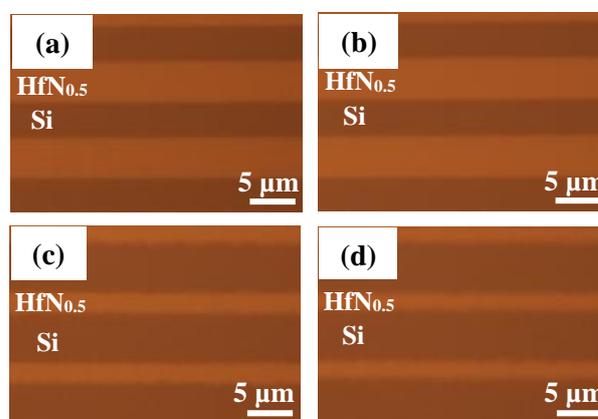


Figure 1 Top views of HfN_{0.5} narrow line after (a) 20 s, (b) 120 s, (c) 180 s, and (d) 195 s etching.

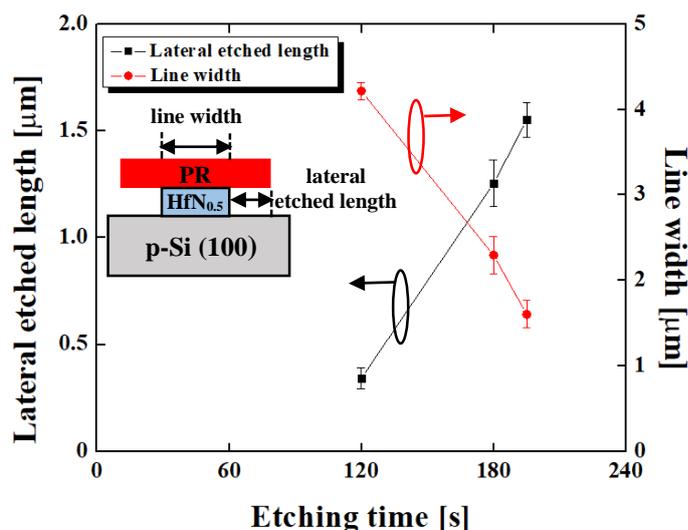


Figure 2 Lateral etching length of HfN_{0.5} film.