

Plasma Etching Behavior of Y_2O_3 coatings by SF_6 Plasma Pre-Treatment

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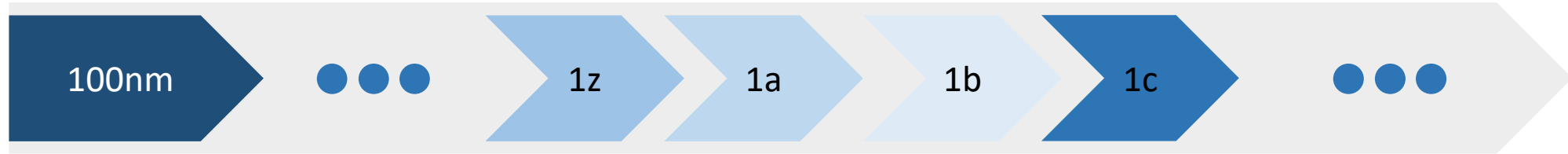
DRAM scaling down challenges & overcome

Past

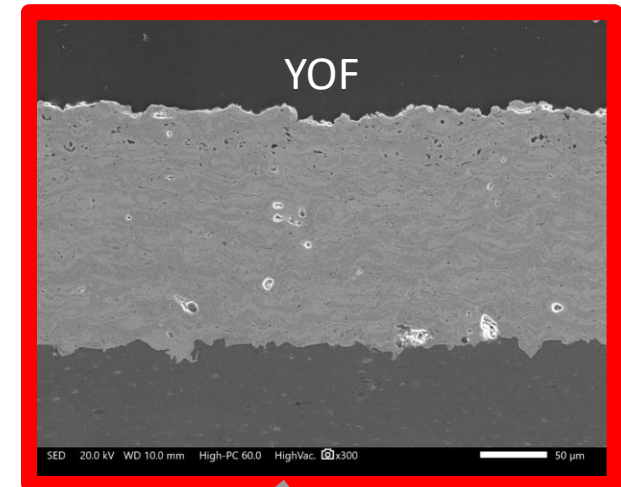
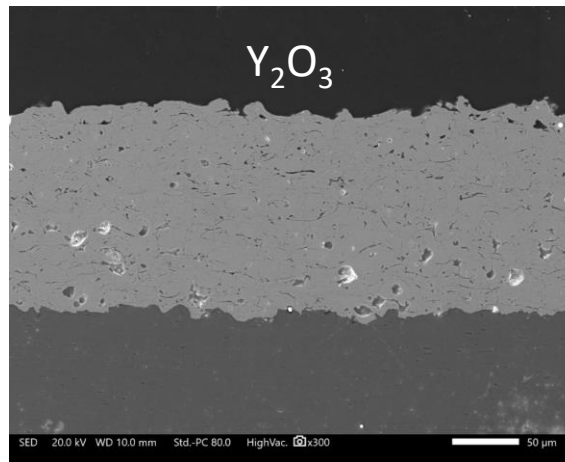
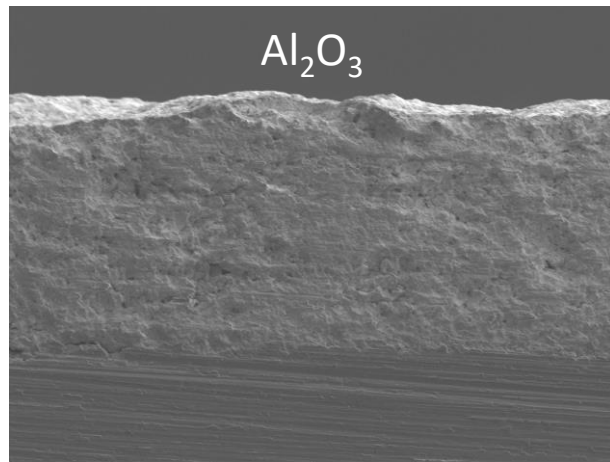
Present

Future

Cell Size



Coating Material



2005

Future



Background: Problem after replacing the inner chamber wall

- Y_2O_3 ceramic coating materials are extensively utilized on the inner chamber wall.
- First, the initial etching rate in the process chamber decreased.
- Second, the etching rate in the process chamber gradually increased.

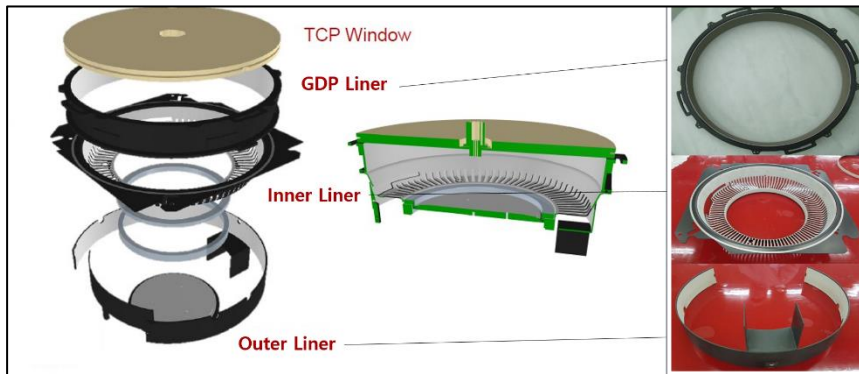


Fig. 1. Liner Parts (Inner Chamber Wall)

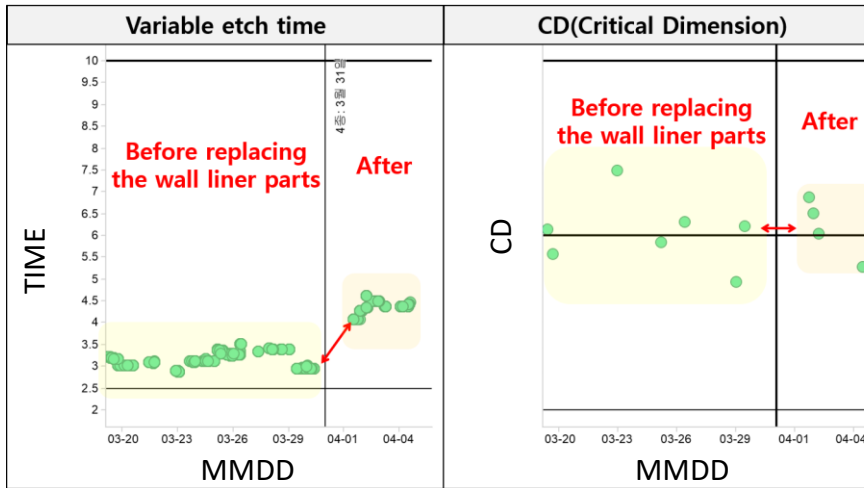


Fig. 2. Shift of the variable time to control with the same CD at a low etching rate after replacing wall liner parts.

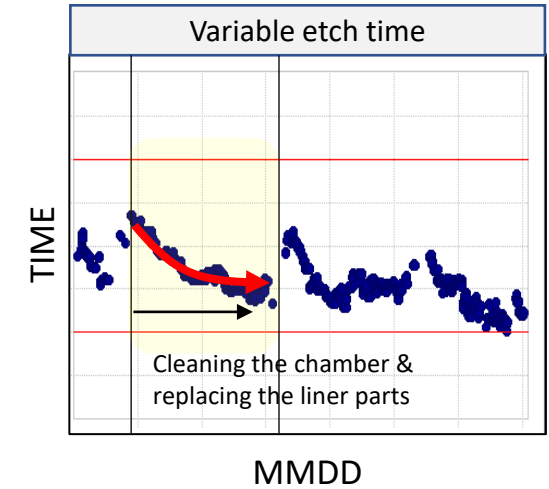


Fig. 3. Variable time depending on the date after replacing wall liner parts.



Analyze: Fluorination of Y_2O_3 coating material

- XPS analysis was performed at the end of the lifetime of the Upper and Inner liner.
- The F component was presented in the Y_2O_3 coating
- It's **Fluorination reaction.**

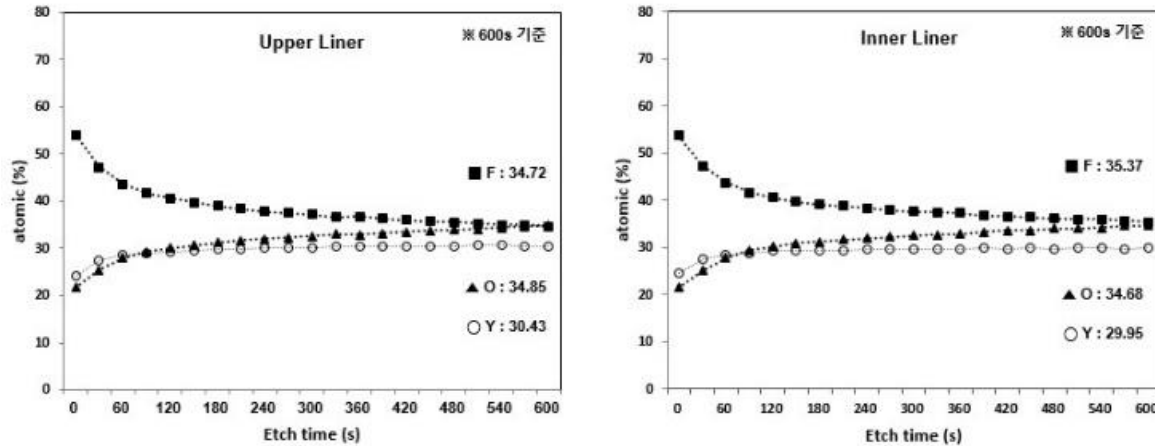


Fig. 4. Variations of chemical compositions measured using XPS with the sputtering time of the Upper Liner and Inner Liner parts after exposing to the fluorine plasma.

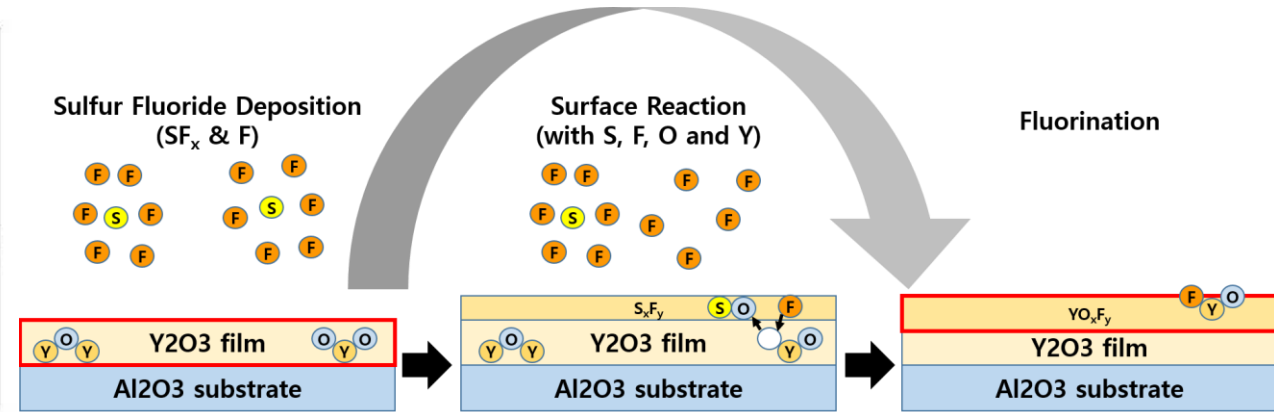


Fig. 5. Fluorination reaction of Y_2O_3 film after exposing fluorine plasma.

Solution: Pre-Treatment

- expected outcomes and Pre-Treatment conditions

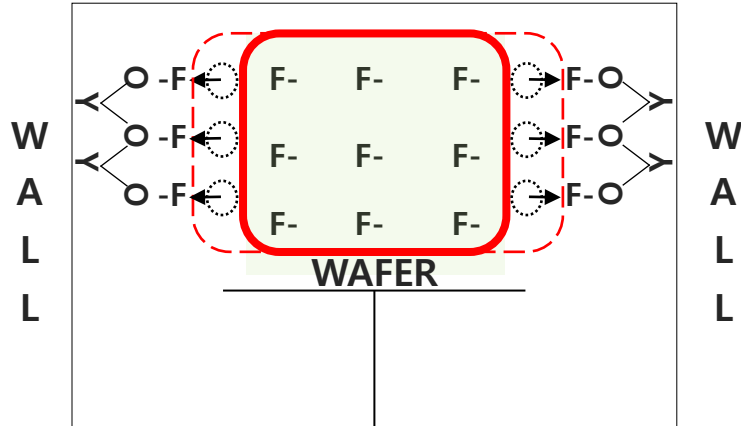


Fig. 6. Process chamber before pre-treatment

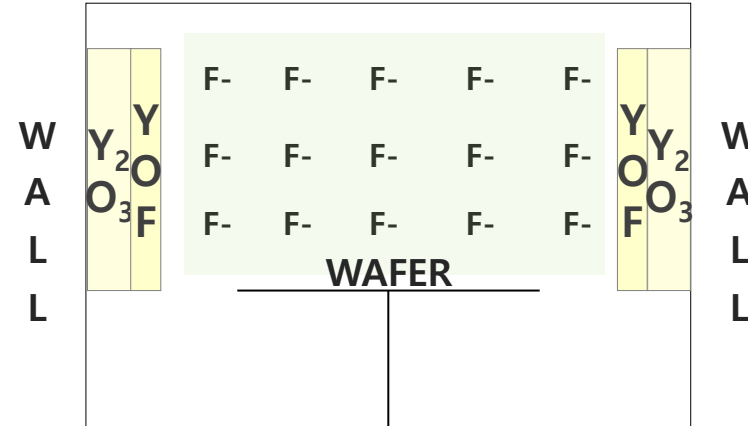


Fig. 7. Process chamber after pre-treatment

Parameters	Non-treatment	Pre-treatment
RF power(W)	-	1000
RF power, bias(W)	-	100
Pressure(mTorr)	-	80
SF ₆ (sccm)	-	200
Etching time(min)	-	720

Table 1. Plasma etching parameters applied in this experiment to investigate the influence of SF₆ plasma pre-treatment.



Result : Improvement effect

- The initial etching rate of the process chamber decreased less by Pre-Treatment.
- The etching rate of the process chamber increased slightly.

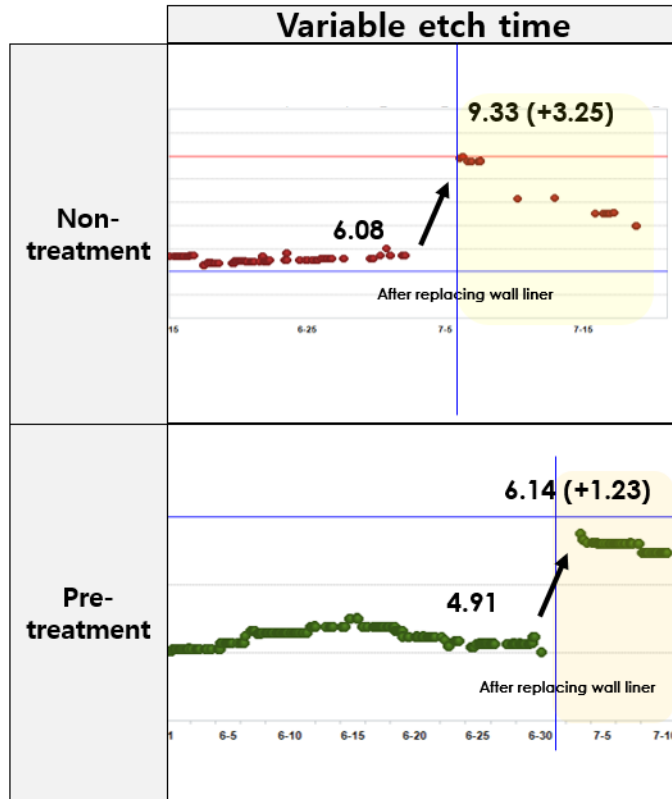


Fig. 8. Variable etch time trend of non-treatment and pre-treatment in etch process.

After replacing the wall liner parts	Time Drift
Non-treatment	+3.25
Pre-treatment	+1.23

Fig. 9. The difference in time drift between non-treatment and pre-treatment After replacing the wall liner parts.

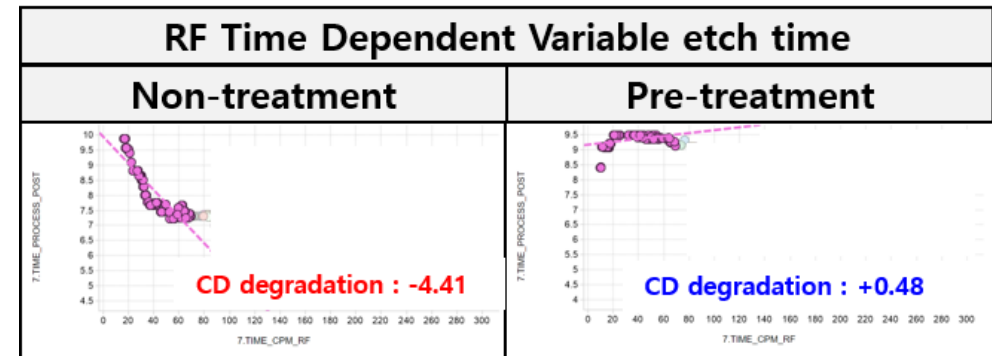


Fig. 10. Variable etch time slope according to RF time(<65hr) before and after SF₆ plasma pre-treatment in etch process.



Conclusion & Future

- Conclusion
 - . Because of the **fluorination reaction** of Y_2O_3 , the initial process condition of the chamber is **unstable**.
 - . When **pre-treatment** is performed, the initial process condition is **relatively stable**.

- Future coating material
 - . **Pre-treated Y_2O_3 coating** requires up to 12 hours and is **unproductive**.
 - . Since **YOF coating** does not require pre-treatment, it can be an **alternative** to pre-treated Y_2O_3 coating.

Types of liner parts coating	Pre-treatment duration
Y_2O_3	12h
YOF	0h

Table 2. Required Pre-treatment Time by Type of coating for liner Parts.

