Abstract #2100, 224th ECS Meeting, © 2013 The Electrochemical Society

NUMERICAL CALCULATION MODEL OF SiO_2 FILM ETCHING BY HF AQUEOUS SOLUTION USING SINGLE WAFER WET ETCHER

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Introduction

By extending our previous study [1] which evaluated the water flow on the rotating wafer, the chemical etching of silicon dioxide (SiO_2) film by hydrogen fluoride (HF) aqueous solution using the single wafer wet etcher was numerically calculated [2]. In this paper, the numerical calculation model for the nozzle fixed at the wafer center and for that swinging above the rotating wafer was discussed in detail.

Experimental

Fig. 1 shows the single-wafer wet etcher used in this study. This etcher has a 200-mm diameter wafer rotating at the rate of 100 – 1400 rpm in a cylindrical-shaped vessel. The HF aqueous solution (3%) was supplied through a nozzle set above the wafer at 1 L/min.

Numerical calculation

Fig. 2 shows the three dimensional axisymmetric numerical calculation model developed for the single-wafer wet etcher. The HF aqueous solution is supplied from (a) center nozzle and (b) non-center nozzle.

Results and discussion

As shown in Fig. 3 for the nozzle fixed above the wafer center, the etching rate of a SiO_2 film by the HF aqueous solution over a rotating 200-mm diameter silicon wafer was numerically obtained using the model shown in Fig. 2 (a). The calculation showed that the etching rate increases with the increasing rotation rate. Additionally, the major trend of the etching rate, such as the etching rate decrease from the wafer center to its edge, was similar to the measurement.

Additionally, the calculation employing the cylindrical nozzle, as shown in Fig. 2 (b), could reproduce the major trend of the etching rate, such as the maximum etching rate near the outside edge position of the swinging nozzle. In order to study the influence and role of a swinging nozzle, the assumption of a cylindrically-shaped nozzle is expected to be practical.

Conclusions

The etching rate of a SiO_2 film by HF aqueous solution over a rotating 200-mm diameter silicon wafer using the single wafer wet etcher was measured and calculated by means of computational fluid dynamics accounting for the surface chemical reaction. Etching rate using the nozzle fixed and swinging above the rotating wafer could be reproduced by the numerical calculation, applying the simple and practical model.

References

[1] H. Habuka *et al*,, *J. Electrochem. Soc*., 1**58**, H487 (2011).
[2] H. Habuka *et al*., *Mater. Sci. Semicond. Process.*, **15**, 543 (2012)

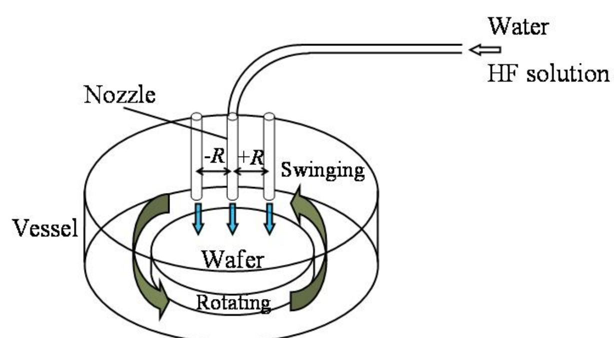

Fig. 1 Single-wafer wet cleaner for 200-mm diameter wafer used in this study..

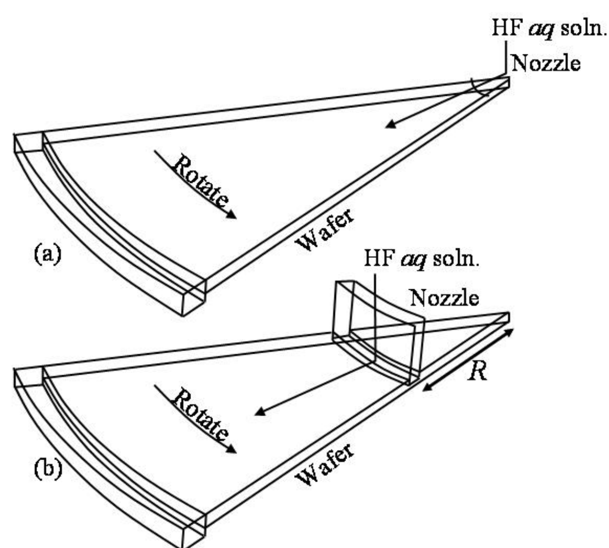

Fig. 2 Geometry of single-wafer wet etcher for taking into account (a) center nozzle and (b) non-center nozzle.

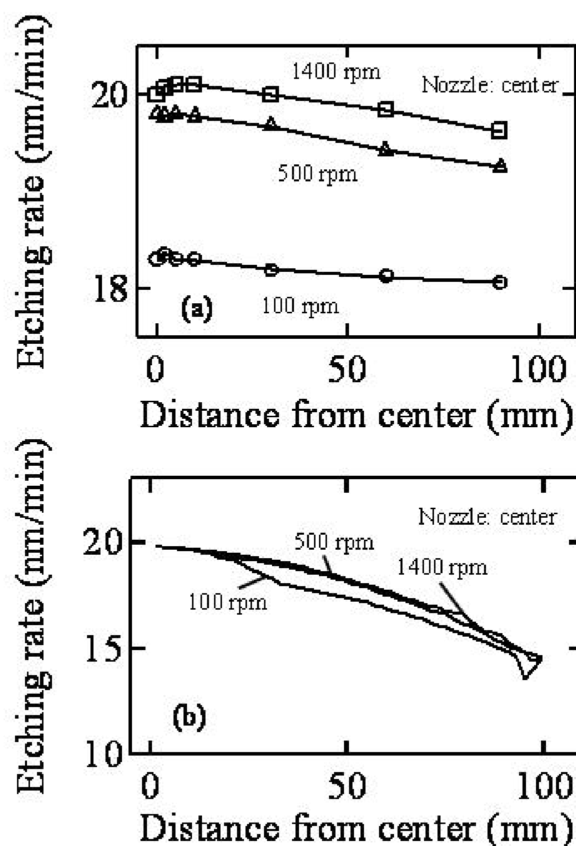

Fig. 3 SiO_2 film etching rate profile obtained by (a) measurement and (b) calculation.