

Characteristics of Silicon CMP with Developed Simultaneous Double-side CMP Machine

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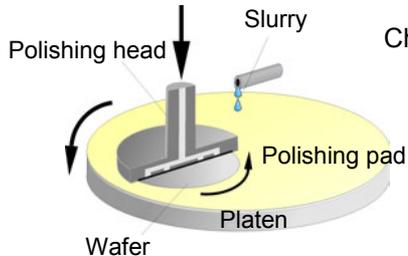
- Background and Purpose

Background

Semiconductor materials whose surface must be machined ultra smoothly

Need to be machined accurately and efficiently

How do we machine them? **“CMP process”**



Chemical reaction → Polishing characteristics

Sensitivity of chemical reactions is influenced with the environment such as temperature, gas, pressure.

Controlling environment around the workpieces

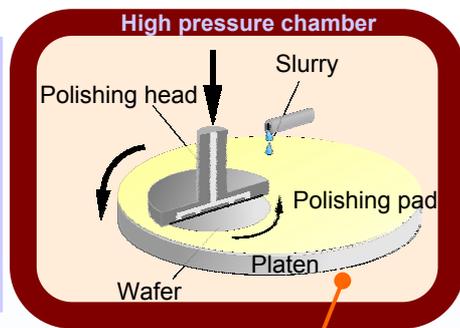
Processing characteristics are improved

CMP Chemical Mechanical Polishing

Surface of the wafer is removed by the combined actions between **chemical reactions** of the chemical additives in slurry and **mechanical actions** of the polishing pad and abrasives.

Purpose

To establish a CMP processing method for machining wafers more efficiently with higher quality by controlling environment around workpieces.



Controlled environment
(type of gas, pressure)

In this presentation

- Developed double-side simultaneous CMP machine which has capability to control environment
- Influences of atmospheres on characteristics of Si CMP with the developed machine
- Influences of atmospheres on characteristics of SiC CMP with the machine

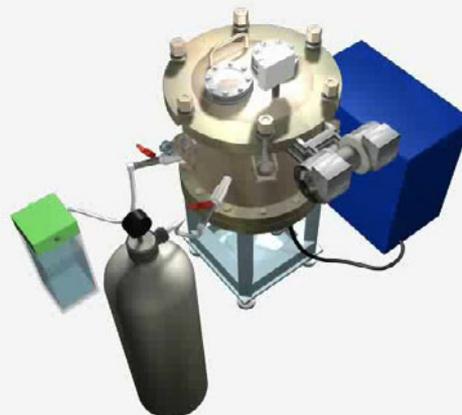
Contents

- Experimental Setup and Conditions
 - Simultaneous double-side CMP machine
 - CMP experiments conditions

Design of developed double-side simultaneous CMP machine



Setup of the machine
which contains whole polishing
elements inside a pressure chamber



Motion of the machine

Specifications of developed double-side simultaneous CMP machine

Machine size		800 ^W 1170 ^D 1100 ^H [mm] (Control unit: 300 ^W 400 ^D 600 ^H)
Upper/lower platen	Material, diameter	Stainless steel, 150 [mm]
	Rotational speed	10~100 [min ⁻¹]
Size of processible workpiece diameter		50~100 [mm]
Type of processing pressure		Deadweight method
Wafer carrier	Diameter, wobbling radius	237 [mm], 15 or 20 [mm]
	Wobbling speed	3~30 [min ⁻¹]
Type of supplying slurry		Circulation method
Inner gas pressure resistance		-100 ~ +1000 [kPa] (Gauge)
Applicable gas atmosphere		Air, O₂, N₂, Ar, etc.
Ultraviolet light		ON / OFF

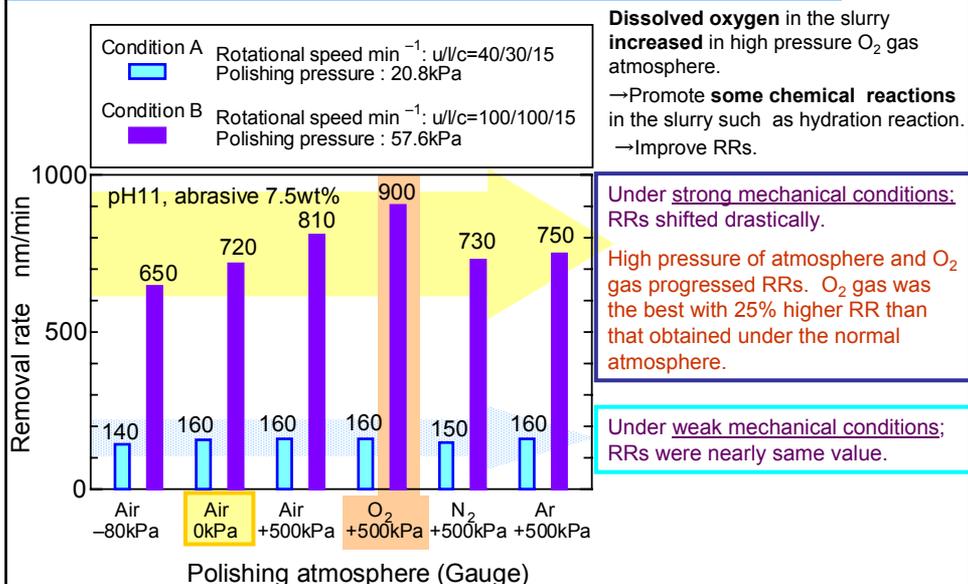
Experimental conditions for Si CMP

Workpiece, diameter, number of wafers machined simultaneously in one processing		Si wafer, 50 [mm], 3 wafers
Polishing pad material, diameter		Polyurethane (Perforate-type) 150 [mm]
Slurry	Abrasive	Colloidal silica (dia. 80 [nm])
	Abrasive concentration	7.5 [wt%]
	pH	11.0
Rotational frequency of carrier driver		15 [min ⁻¹]
Processing time		10 [min]
Processing pressure		20.8 / 39.2 / 57.6 [kPa]
Processing atmosphere		· Air at +0/+500 [kPa] (Gauge) · O₂/N₂/Ar at +500 [kPa](Gauge)
Ultraviolet light		OFF

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● Highlight Data

Effect of polishing atmospheres around workpieces on RR (removal rate)



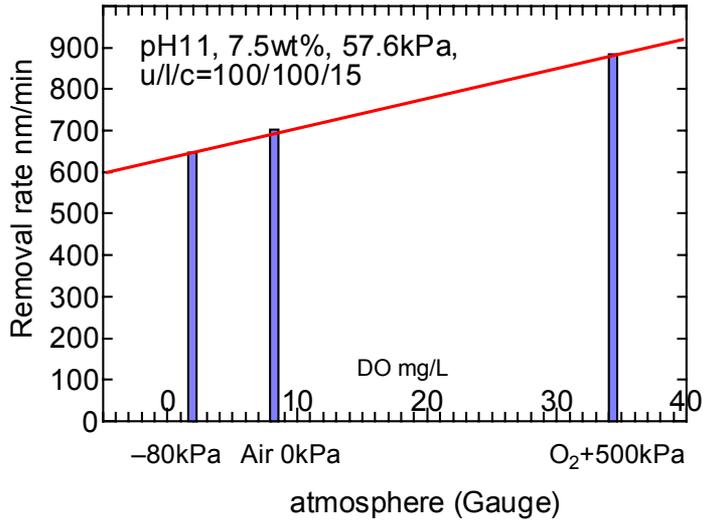
Dissolved oxygen in the slurry **increased** in high pressure O₂ gas atmosphere.
→Promote **some chemical reactions** in the slurry such as hydration reaction.
→Improve RRs.

Under strong mechanical conditions: RRs shifted drastically.

High pressure of atmosphere and O₂ gas progressed RRs. O₂ gas was the best with 25% higher RR than that obtained under the normal atmosphere.

Under weak mechanical conditions: RRs were nearly same value.

Dissolved oxygen vs. RR



RR was increased in proportion to dissolved oxygen.

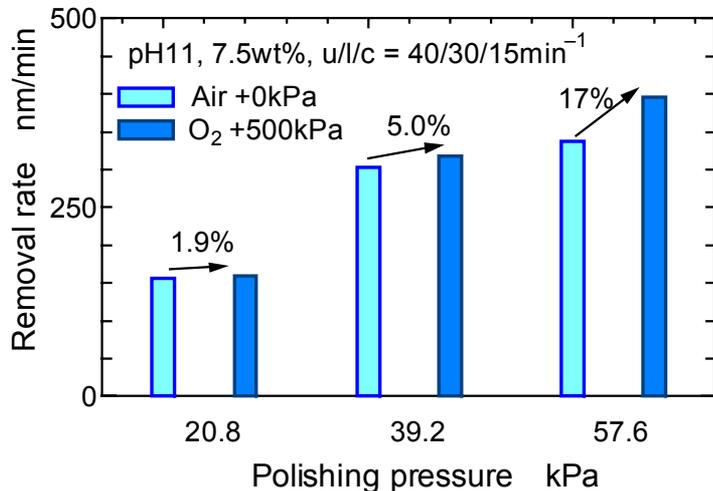
Polishing pressure vs. RR

As a former result,

Under strong mechanical condition

→ High pressure of atmosphere and O₂ gas progressed the RRs.

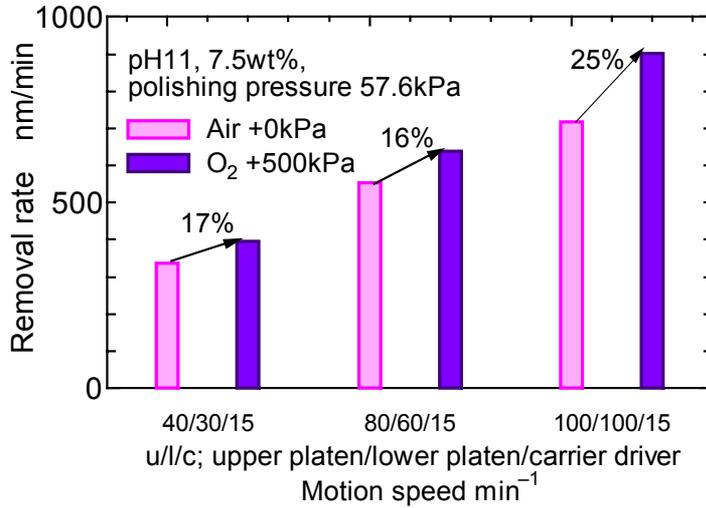
Effect of mechanical condition?



High polishing pressure showed high RR.

→ In the high pressure and O₂ gas atmosphere, this trend was clear.

Platen speed vs. RR

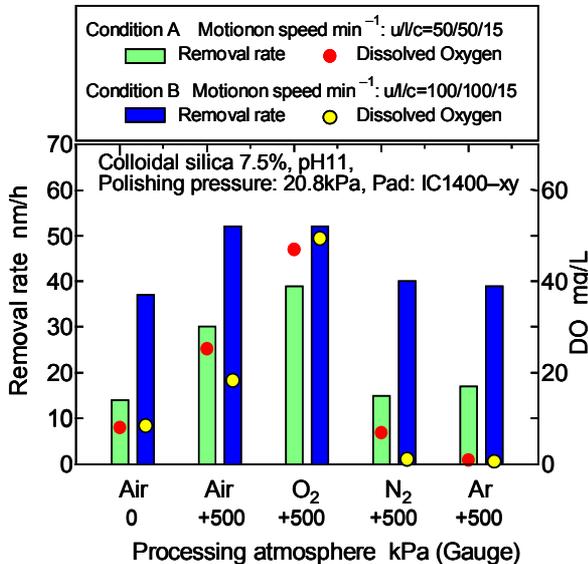


High motion speed showed high RR.

→In the high pressure and O₂ gas atmosphere, this trend was clear.

Application:

Effect of polishing atmospheres in SiC CMP



Under strong mechanical conditions; RRs shifted drastically.

High pressure of atmosphere and O₂ gas progressed RRs. O₂ gas was the best with 40% higher RRs than that obtained under the normal atmosphere.

Under weak mechanical conditions;

High pressure of atmosphere and O₂ gas progressed RRs.

Contents

- Summary

Summary

The effective actions of various high pressure atmospheres were investigated with the developed double-side simultaneous CMP machine.

As the results,

- In Si CMP, remarkable effect of oxygen gas atmosphere was observed under strong mechanical action conditions, ex. high polishing pressure and high platen rotational speeds.
- In SiC CMP, machining process showed a similar trend of Si CMP.