

# Resistivity Control of Cutting Water with CO<sub>2</sub> Injector and Hub Blade Wear

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## Abstract

In the blade dicing process, static electricity is generated during workpiece processing/cleaning, which leads to electrostatic discharge (ESD) in the workpiece. As one ESD countermeasure, DISCO has adopted technology that mixes CO<sub>2</sub> into the cutting water supplied during processing using a CO<sub>2</sub> injector, controlling the resistivity of the cutting water. While the workpiece's electric charge does decrease as the amount of CO<sub>2</sub> supplied increases, wear to the hub blade tends to increase. However, with DISCO's standard resistivity of 0.5 M to 1.0 MΩ/cm, blade wear is comparable to that with DI water.

## 1. Introduction

As semiconductor miniaturization progresses, the requirements have increased for electrostatic discharge anti-countermeasures in blade dicing saw equipment (hereinafter referred to as dicers).

DISCO has clarified the root cause of static electricity and has taken the following measures to control electrostatic discharge.

1. Installed CO<sub>2</sub> injector<sup>(1)</sup> (decreases resistivity of DI water)
2. Installed ionizer (removes electric charge on workpiece)
3. Controlled ascension rate of transfer arm (makes change in capacitance more gradual)

Details are provided in past technical reviews<sup>(2)</sup>.

This report examines “1. Installed CO<sub>2</sub> injector” and presents investigation results regarding ESD countermeasure effectiveness and hub blade wear.

## 2. Test method

### 2-1 Measurement of Si wafer electric charge generated by contact with water

After a ø12-inch, 775 μm thick Si wafer was mounted to a frame with SPV224 tape (Nitto), the frame was mounted on the dicer spinner table. The nozzle supplied cutting water at each resistivity to the wafer surface at 6 MPa, spin-dry was performed, and electric charge was measured after removal from the spinner table.

Electric charge at the time of removal was measured using the ZJ-SD100 (OMRON) static electricity sensor, which was placed in the transfer area directly above the wafer.

For water resistivity, three values were tested: 18 MΩ·cm (DI water, no CO<sub>2</sub>), 0.9 MΩ·cm, and 0.5 MΩ·cm.

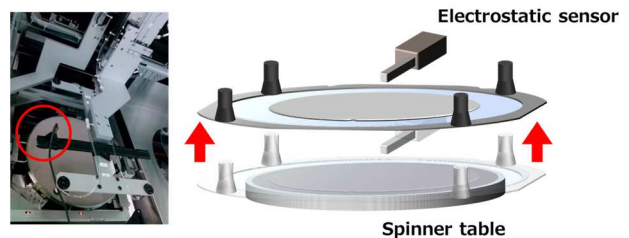


Figure 1. Measurement of wafer electric charge

## 2-2 Blade wear measurement

After a hub blade was installed and precut was performed, thirteen  $\phi$ 12-inch, 400  $\mu$ m thick Si wafers were processed. After the wafers were processed, blade wear was measured with the non-contact setup function<sup>(3)</sup> using a transmission-type sensor installed to the equipment. After the 13 wafers were processed, the blade was inspected by SEM. For water resistivity, three values were tested: 18 M $\Omega$ ·cm (DI water, no CO<sub>2</sub> supply), 0.5 M $\Omega$ ·cm, and 0.1 M $\Omega$ ·cm.

The equipment and blade used for processing are shown in tables 1 and 2.

**Table 1. Blade used and precut condition**

Blade Used, Dress Condition		
Equipment used	DFD6362	
Blade used	ZH05-SD2000-N1-70 DD	
Dresser board	N/A	
Precut Condition		
Precut wafer	Si $\phi$ 12 inch x 0.40 mm thick	
Spindle RPM [/min]	30,000	
Cutting depth [mm]	0.02 into the tape	
Step 1	Feed speed [mm/s]	1,3,5,7,9
	# of lines [lines]	3 each
Step 2	Feed speed [mm/s]	10,15,20,25
	# of lines [lines]	10 each

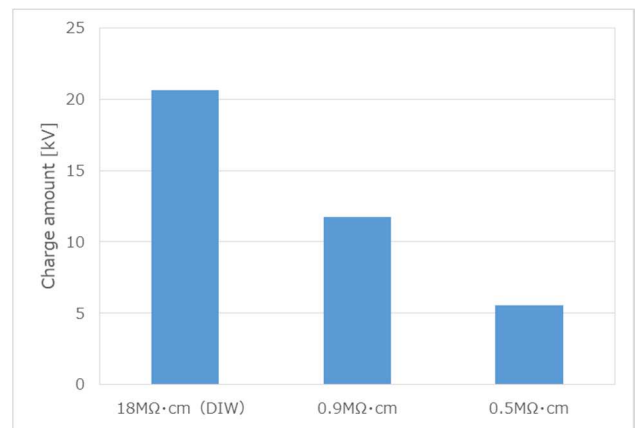
**Table 2. Processing condition**

Process Condition		
Wafer processed	Si $\phi$ 12 inch x 0.40 mm thick	
Index (CH1 x CH2) [mm]	3 x 3	
Spindle RPM [/min]	30,000	
Feed speed [mm/s]	30	
Cut mode	A	
Cutting depth [mm]	0.02 into the tape	
Water amount [L/min]	Blade cooler	1.5
	Shower	1.0
	Spray	0
Flange size [mm]	Hub mount	
Dicing tape	SPV-224	
Process time	7 hours 11 minutes	

## 3. Measurement results and remarks

### 3-1 Measurement of Si wafer electric charge generated by cutting water

The electric charge of the wafers upon removal from the spinner table is shown in figure 2. It was confirmed that the electric charge decreases monotonically as the amount of CO<sub>2</sub> supplied is increased and water resistivity is decreased. It is suspected that reduced resistivity decreases triboelectric charging on the wafer surface when the water makes contact.



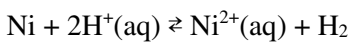
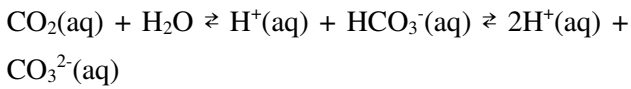
**Figure 2. Water resistivity and electric charge upon removal from spinner table**

### 3-2 Blade wear

Figure 3 shows trends in blade wear when wafers were processed under each condition. No drastic difference in blade wear was observed with the resistivity of 0.5 MΩ·cm compared to with DI water. However, a drastic increase in blade wear was observed with the resistivity of 0.1 MΩ·cm. Blade wear after processing 13 wafers was 43 μm with the resistivity of 0.5 MΩ·cm but was 67 μm with the resistivity of 0.1 MΩ·cm, which was 1.5x the wear.

Figure 4 shows the SEM images of the blade edge before and after processing. Comparing to that with DI water and the resistivity of 0.5 MΩ·cm, grit on the blade edge was more exposed after 13 wafers were processed with the resistivity of 0.1 MΩ·cm, confirming that the Ni bond that secures the diamond grit is being eluted.

It is assumed that increasing the supply of CO<sub>2</sub> caused the pH of the cutting water to decrease and eluted the Ni bond of the blade, leading to blade wear as a result.



As reference, the relationship between water resistivity when CO<sub>2</sub> is dissolved in the water and pH is shown in the figure 5. This diagram was calculated from internal testing and measurement errors are included.

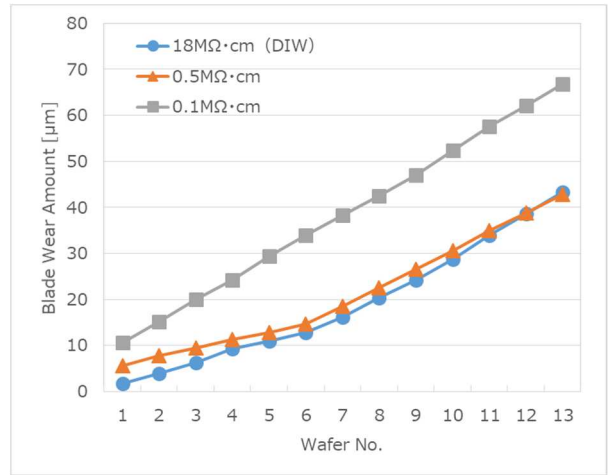


Figure 3. Blade wear trends

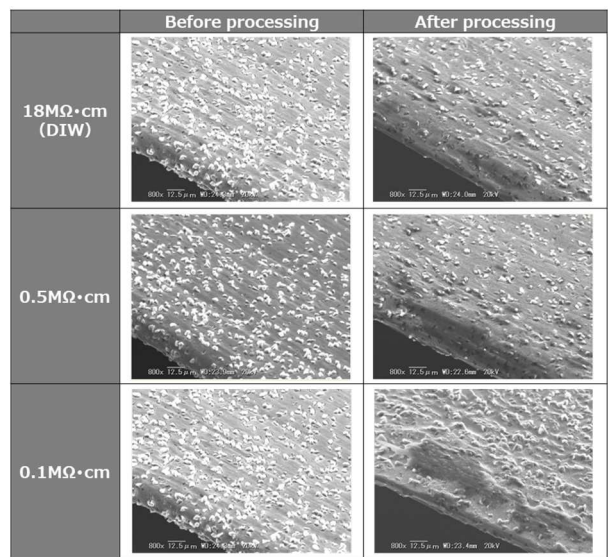


Figure 4. SEM images before and after processing

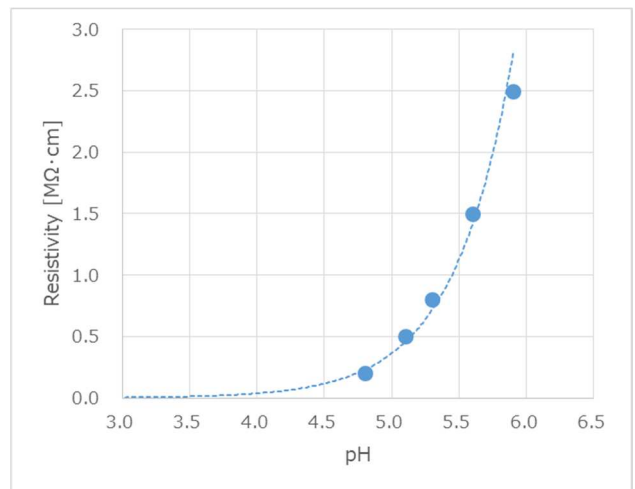


Figure 5. Water resistivity when CO<sub>2</sub> is dissolved and pH

#### 4. Conclusion

Based on the test results, a workpiece's electric charge decreases when CO<sub>2</sub> supply is increased and water resistivity is decreased. On the other hand, Ni eluting reaction accelerates, leading to an increase in blade wear.

At the resistivity of 0.5 MΩ·cm, a decrease in electric charge was observed. In addition, blade wear comparable to that with DI water was achieved.

For that reason, the CO<sub>2</sub> injector at DISCO sets 0.5 M–1.0 MΩ·cm as the standard for resistivity.

\*Blade wear changes depending on the bond type and environment, and thus, these are reference values and are not guaranteed.

#### References

- (1) DISCO website: Product Information / Accessory Equipment / CO<sub>2</sub> Injector

<https://www.disco.co.jp/eg/products/accessory/co2.html>

- (2) DISCO Technical Review “Wafer ESD in dicing saws and the effect of the countermeasures (TR16-02)”

[https://www.disco.co.jp/eg/solution/technical\\_review/doc/TR16-02\\_Wafer%20ESD%20in%20dicing%20saws%20and%20the%20effect%20of%20the%20countermeasure\\_20160610.pdf](https://www.disco.co.jp/eg/solution/technical_review/doc/TR16-02_Wafer%20ESD%20in%20dicing%20saws%20and%20the%20effect%20of%20the%20countermeasure_20160610.pdf)

- (3) DISCO website: Solutions / Blade Dicing / The Advantages of Non-Contact Setup (NCS)

<https://www.disco.co.jp/eg/solution/library/dicing/setup.html>