

## The RIE-600iP/600iPC

### “Dry Etching Systems Designed for SiC Power Device Manufacturing”

[SAMCO Inc. R&D division]

#### Introduction

Silicon Carbide (SiC), a wide-bandgap semiconductor, is superior to silicon in voltage endurance and thermal conductivity. It is attracting many researchers with its applications to power devices. As a result, many projects designed to commercialize SiC power devices are in progress.

To meet the increasing demand for SiC etching, SAMCO launched the RIE-600iP, the first dry etching system specially designed for SiC etching in Dec. 2012, and subsequently released the RIE-600iPC, a mass production system in Oct. 2013.

The RIE-600iP/600iPC employ a newly-developed tornado coil, and enables high RF power to generate stable, high density plasma. Additionally, the RIE-600iP/600iPC employ a height-adjustable lower-electrode and large vacuum pump (1300L/sec), which enable a wide range of process windows.

The RIE-600iP/600iPC are capable of  $\phi 6$  inch wafer (single wafer processing). The production type RIE-600iPC can process 25  $\phi 6$ -inch wafers per batch.

We have been developing SiC etching technology for trench and via-hole for power device fabrication. This paper reports on the SiC trench etching achieved by the the RIE-600iP/600iPC .

#### SiC Trench Etching

What posed a major challenge for researchers in SiC trench etching was to achieve high etch rate ( $>500\text{nm}/\text{min}$ ) and high selectivity ( $\text{SiC}/\text{SiO}_2$ ), while maintaining both good etch profile (i.e. vertical etching, no-subtrenches) and smooth sidewall with existing etching systems.

The newly-developed the RIE-600iP/600iPC achieved much higher etch rate and higher selectivity ( $\text{SiC}/\text{SiO}_2$ ) compared to the existing etching systems. Fig. 1 and Fig. 2 show the results of SiC trench etching achieved by the RIE-600iP/600iPC. The etch rate was over  $500\text{nm}/\text{min}$ , and the selectivity ( $\text{SiC}/\text{SiO}_2$ ) was approximately 15. Additionally, the RIE-600iP/600iPC achieved a better etching profile and smoother sidewall than the existing systems.

The RIE-600iP/600iPC achieved SiC trench etching with high etch rate, high selectivity ( $\text{SiC}/\text{SiO}_2$ ), and vertical smooth sidewalls without subtrench. We will work further to improve the etch rate and selectivity ( $\text{SiC}/\text{SiO}_2$ ), and will conduct more research on etch profile control, selectivity of SiC over other mask materials., and etching uniformity. Lastly, the RIE-600iP/600iPC can be used in other applications than MOSFET, such as MEMS and LED. We will provide new process solutions for such applications, using the RIE-600iP/600iPC.

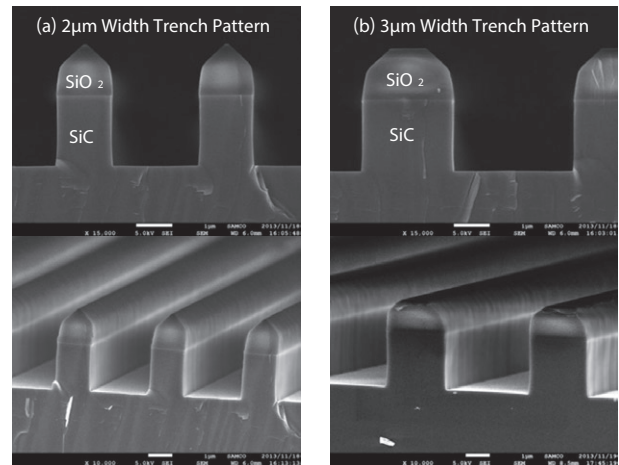


Fig.1 SiC Trench Etching (Etch Depth:  $2\ \mu\text{m}$ )

Mask:  $\text{SiO}_2$   
SiC Etch Depth:  $1.96\ \mu\text{m}$

SiC Etch Rate:  $652\text{nm}/\text{min}$   
Selectivity( $\text{SiC}/\text{SiO}_2$ ): 4

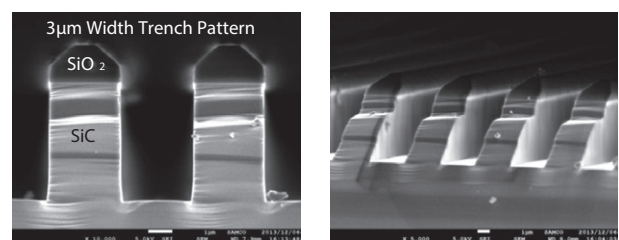


Fig. 2 SiC Trench Etching (Etch Depth:  $5\ \mu\text{m}$ )

Mask:  $\text{SiO}_2$   
SiC Etch Depth:  $4.86\ \mu\text{m}$

SiC Etch Rate:  $572\text{nm}/\text{min}$   
Selectivity( $\text{SiC}/\text{SiO}_2$ ): 15



RIE-600iPC  
“Cassette-to-Cassette” System  
for SiC Power Device Manufacturing