Introduction to the 700°C High-Temperature PECVD System PD-101TC

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Introduction

Plasma-enhanced chemical vapor deposition (PECVD) systems were initially developed for low-temperature film deposition. However, recent diversification in research and development needs has led to a demand for systems capable of high-temperature film deposition. PECVD systems, a cornerstone of Samco, utilize silicon tetrahydride (SiH_4) gas for silicon nitride (SiN) and silicon dioxide (SiO_2) film deposition. Additionally, Samco Inc. has developed a unique liquid source chemical vapor deposition (LSCVD) technology, prioritizing safety by employing liquid materials such as TEOS. Furthermore, Samco's proprietary cathode-type PECVD systems apply radio frequency power to the lower electrode and utilize ionic active species to achieve high-speed, thick film deposition. These systems are highly regarded in the fields of optical waveguides and high-frequency filters. To address the diverse needs of research and development applications, Samco developed the PD-101TC PECVD system, which supports both thermal decomposition and plasma deposition. This system can achieve wafer surface temperatures of up to 700°C. This report presents the temperature rise performance of the PD-101TC.

System Overview

Photo 1 shows the external appearance of the PD-101TC. The system features a high-temperature heater located on the lower electrode, capable of raising the wafer surface temperature to 700°C, with a heater setting temperature of 900°C. Additionally, the PD-101TC includes a vacuum cassette chamber and robot transfer, facilitating the direct transfer of 3- or 4-inch wafers or the use of 4-inch carrier trays.

Photo 1. 700°C High Temperature PECVD System PD-101TC

Temperature Rise Performance

Conventional Samco PECVD systems have a maximum heater temperature of 400°C. In contrast, the PD-101TC utilizes a specialized heater, enabling temperature settings exceeding 900°C. A comparison of temperature rise rates between the PD-101TC and a conventional PECVD heater is illustrated in Figure 1. The temperature rise rate of the PD-101TC is eight times greater than that of the conventional heater.

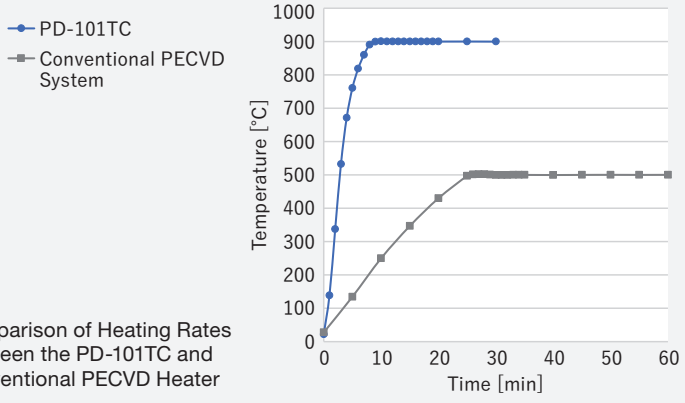


Figure 1. Comparison of Heating Rates Between the PD-101TC and Conventional PECVD Heater

Figure 2 compares the set temperature of the lower electrode heater with the measured wafer surface temperature. Measurements were taken at five locations: four points situated 5 mm from the wafer edge and the center, using a silicon wafer equipped with a thermocouple. Due to the vacuum insulation layer between the lower electrode heater and the wafer surface, a temperature difference of approximately 20% is observed. Nonetheless, the wafer surface temperature demonstrates a linear correlation with the heater setting temperature, enabling precise control for wafer surface temperatures up to 700°C.

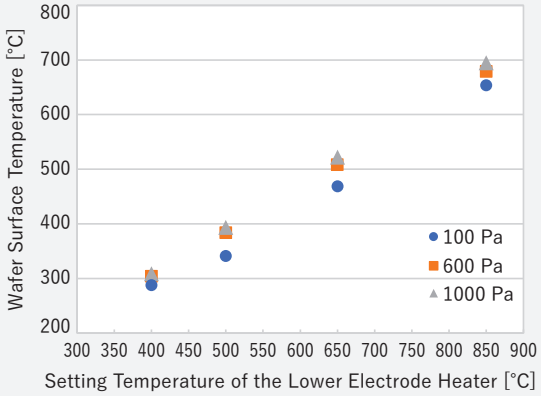


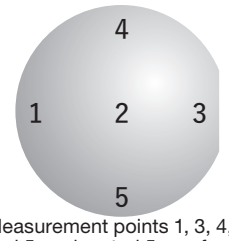
Figure 2. Lower Electrode Heater Setting Temperature and Wafer Surface Temperature

Table 1 presents the temperature distribution at a lower electrode heater setting temperature of 900°C with a N_2 flow rate of 300 sccm. The achieved temperature at 100 Pa is 662.7°C, with a favorable temperature uniformity within the wafer surface of ±5.2°C or less.

	Measurement Points					Average Temperature	Temperature Difference [±]
	Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5		
Temperature Measurement [°C]	659.3	667.8	665.4	657.4	663.6	662.7	5.2

Table 1. Wafer Surface Temperature Uniformity at a Lower Electrode Heater Setting Temperature of 900°C (100 Pa)

5 Measurement Points



Measurement points 1, 3, 4, and 5 are located 5 mm from the wafer edge.

TEOS-SiO_2 film deposition experiments were conducted at lower electrode heater setting temperatures of 500°C and 800°C. The results, presented in Figure 3, reveal that film deposition at 800°C produces a lower deposition rate and a refractive index of 1.465. This change is attributed to the increased temperature, which facilitates the reduction of impurities and OH groups in the film, leading to enhanced film density.

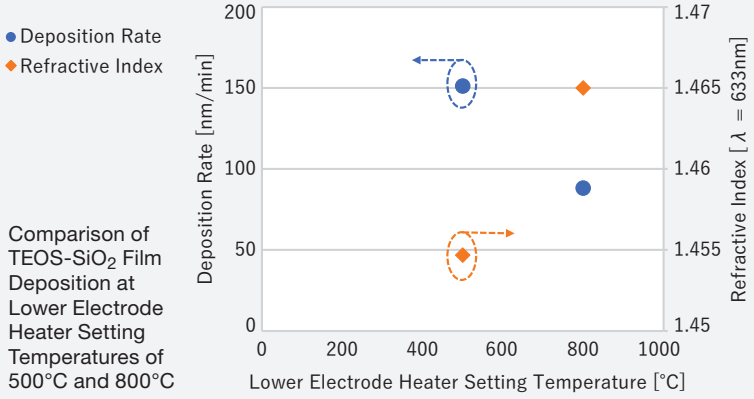


Figure 3. Comparison of TEOS-SiO_2 Film Deposition at Lower Electrode Heater Setting Temperatures of 500°C and 800°C

Conclusion

This report has presented the temperature rise performance of the PD-101TC. Beyond its exceptional heating capabilities, the PD-101TC is a cutting-edge research system equipped with a variety of advanced features, including frequency conversion and adjustable electrode spacing. The PD-101TC is designed to address the evolving requirements of the compound semiconductor and electronic device sectors, facilitating high-quality thin film formation and precise process management. Furthermore, Samco remains dedicated to developing innovative systems that foster new value creation and advance industrial science.

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