

TECHNICAL NOTE

Etch Process Monitoring with the Transpector® Residual Gas Analyzer

INFICON RGAs can be used to give excellent insight into an etch process and have distinct advantages over competitive RGAs. FabGuard™ Integration and Analysis System is often used to integrate the RGA and other diagnostic sensors to the semiconductor manufacturing tool. FabGuard automates data analysis and automatically sends indications of endpoint or faults to the tool. There are 3 key benefits from using an INFICON RGA and FabGuard Integration and Analysis System to monitor an etch process.

DUAL SAMPLING MAXIMIZES THROUGHPUT AND ENHANCES PRODUCT YIELD

Figure 1 is a diagram of the Transpector CIS2 (closed ion source) sampling system. It has a small footprint, excellent sensitivity, ease of use, and the Transpector RGA has a unique method for sampling the etch process. INFICON offers a dual inlet RGA sampling method: one for sampling near the chamber walls and one for sampling near the process using a sniffer type of attachment.

Since the etch process chamber ages, monitoring the chamber walls is often a direct indication of chamber health. After the RGA and FabGuard together “learn” the process, FabGuard notifies the user when it is appropriate to do a wet clean of the etch chamber. This can greatly enhance product yield, as well as maximize throughput.

MINIMIZED FRAGMENTATION IN RGA DATA

INFICON RGAs are able to perform etch monitoring accurately, more efficiently, and with greater long-term stability than competitive RGAs (see Figure 2 on next page). For etch applications, INFICON RGAs can operate with lower electron energies (eV) due to excellent ion optics, quadrupole transmission, and sensitivity. When using RGAs with electron energy in the 70eV range, it is much harder to differentiate between CF_x radical masses that have been created by the RGA or by the plasma of the etch process. This problem tends to dilute the RGAs ability to accurately monitor what is happening at the walls, as well as what is happening from the

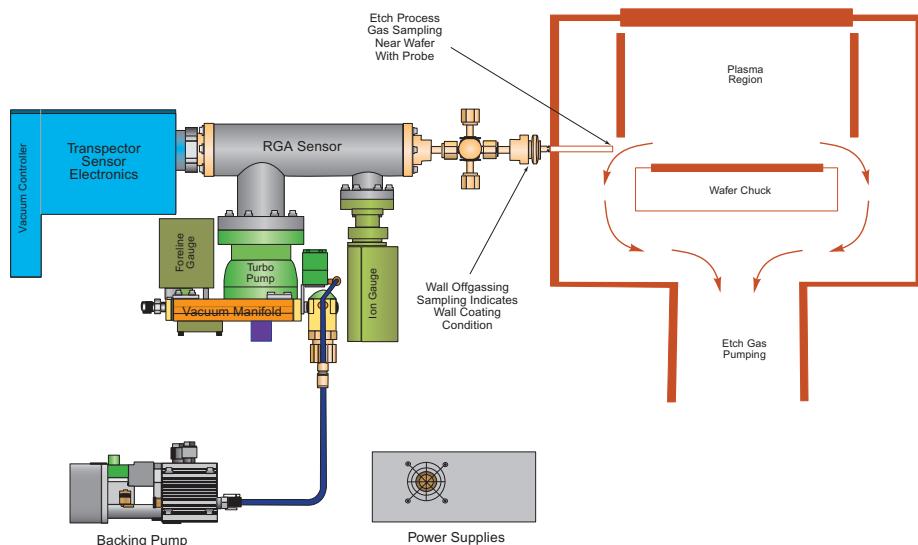


Figure 1: Dual Location Transpector CIS2 Sampling System

plasma. With the Transpector CIS2, electron energy can be very low to minimize fragmentation by the RGA and still have energy to ionize neutral CF_x radicals made in the plasma. Monitoring radicals by RGA species can also provide plasma diagnostic information as the wall conditions change with time.

RELIABLE ENDPOINT DETECTION

Figure 3 shows how a Transpector CIS2 Gas Analysis System

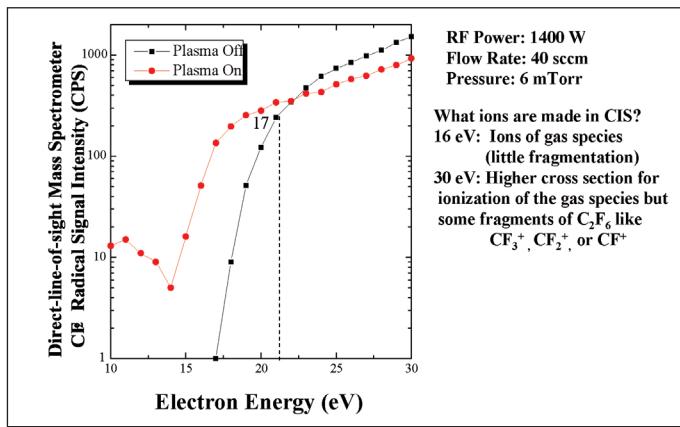


Figure 2: Typical appearance mass spectrometry curves of CF₂ for a C₂F₆ plasma.

can be used to clearly detect endpoint for a SiO₂ etch process. During the steps of the process, trace signals are used to follow how it is proceeding. The CHF₃ plasma breaks into various radicals that attack the material to be etched and, while this occurs, by-products are generated in the form of the radicals, CF₃⁺ and CF₂⁺. These radicals are monitored throughout the process as is the CO⁺ peak.

Monitoring the endpoint of the SiO₂ etching is the most important criteria, and the etch by-product of CO⁺ reaching endpoint is clearly seen from the data in Figure 3. FabGuard sends an endpoint signal to the tool indicating when endpoint is reached.

It is important to ensure that the RGA detects endpoint repeatably and reliably. Endpoint with an RGA is repeatable. As long as the process is within its statistically acceptable range,

FabGuard will not generate a fault. If endpoint is found beyond a time that is not statistically acceptable, FabGuard will still send a fault signal even though endpoint has occurred. This measurement, along with the chamber wall information, helps give a very clear view of process health.

An RGA is an effective tool for monitoring etch applications. The ability of INFICON RGAs to operate at significantly reduced electron energy results in the ability to monitor processes for endpoint, as well as for chamber clean information. Combining all this with powerful integration software gives INFICON the ability to routinely interpret process and chamber health. All of this information leads to better yield and throughput for the tool, keeping cost of ownership of the tool to the optimum level.

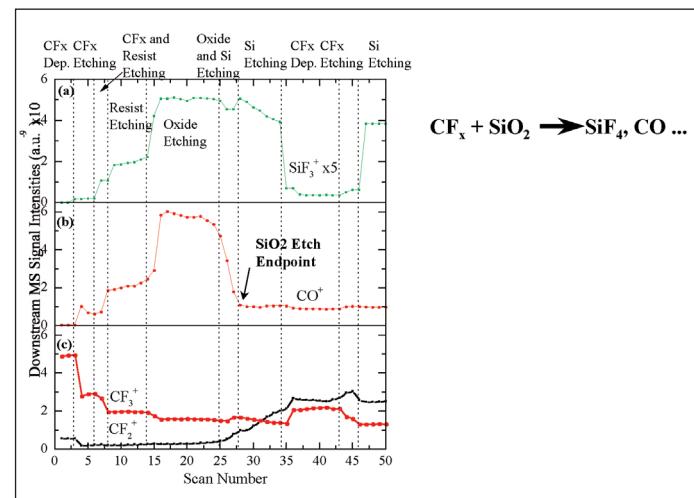


Figure 3: Results of real-time 30eV CIS endpoint detection of several species for an SiO₂ sample etching in a 6mTorr CHF₃ plasma.



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