Reduction of PFC Emissions through Process Advances in CVD Chamber Cleaning

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In the past several years, the semiconductor industry has been presented with various options to reduce PFC emissions from CVD chamber cleaning. There are many ways to reduce emissions, from optimizing the standard cleaning process, "dropping-in" alternatives like c-C4F8, to more broadly changing the cleaning process. In this presentation, we assess the relative merits of the latest chamber cleaning processes. These processes will be compared on the overall cleaning performance (process throughput, quality of clean,) the economic performance (gas usage, costs,) and the environmental performance (PFC emissions.) Direct comparisons will only be made whenever relevant process factors (e.g. , tool type, film, analysis methods) are held constant.

We have previously reported both laboratory and commercial CVD tool results comparing different chamber cleaning gases. In these laboratory studies using both Novellus Concept-I and AMAT P-5000 tools, a "drop-in" alternative such as c-C4F8 was shown to significantly lower emissions by up to 85% as well as decrease gas costs by 60% through reductions in gas consumption. Subsequent commercial studies would validate these laboratory studies. In this paper, we further extend this work to include joint studies with leading chip-makers on a variety of tools, wafer sizes, and films. Film properties such as uniformity, number of particles, and thickness are analyzed during marathon qualification tests at production fabs. Production cleaning processes are also optimized through designs of experiments at various chip-makers.

The purpose of this paper is to present the most recent data highlighting the differences between standard clean processes and the new and improved optimized processes using alternative chemistries.

The overall results support and extend the basic conclusions reached earlier: c-C4F8 has the lowest process cost of any cleaning gas without any penalty in cleaning performance, but most importantly, it also offers the lowest PFC emissions of any fluorocarbon-based process. Marathon qualification tests using c-C4F8 show no change in film properties compared to standard processes as well as no visible damage to tool hardware.

References

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