

Characterization of 200mm Silicon Dioxide Etch Recipes

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Primary CNF Tools Used: Gamma Automatic Coat-Develop Tool, ASML PAS 5500/300C DUV Wafer Stepper, Glen 1000 Resist Strip, KLA P7 Profilometer, Dektak XT Profilometer, Plasma-Therm Takachi HDP-CVD, Oxford 100 ICP Plasma Etcher.

Abstract:

Over the past year, the CNF has expanded many of our tools to accommodate 150mm and 200mm sized wafers. What we quickly learned is that some of our etch recipes for 100mm sized wafers did not directly translate when scaled up to larger wafers. An example of this was etching 200mm silicon dioxide (SiO_2) wafers on the Oxford 100. Our initial test with difluoromethane (CH_2F_2) using the 100mm wafer recipe was not promising, but after some vacuum adjustments, we were able to etch at a rate of ≈ 96 nm/min. The CHF_3/O_2 oxide recipe etches at a rate of ≈ 53 nm/min. For larger molecular fluorocarbons such as C_4F_6 and HFO-1234ze(E), the existing 100mm recipes deposited polymer. By adding oxygen and argon, we can currently etch SiO_2 on 200mm sized wafers using HFO-1234ze(E) at a rate of ≈ 78 nm/min.

The 100mm C_4F_6 and HFO-1234ze(E) recipes both deposited polymer instead of etching the SiO_2 . By adding argon to enhance the ion bombardment and oxygen to reduce polymer formation, we were able to etch SiO_2 using HFO-1234ze(E) at a rate of ≈ 78 nm/min. The etch rates for all three 200mm sized wafer were lower than the 100mm sized wafer rates reported in our 2025 paper (1), but the selectivity to UV 210 DUV resist were much higher. Tables 1 & 2 show, the etch depths for both the CH_2F_2 and CHF_3/O_2 were 3.5-5% lower two-inches from the center and 8-12% lower three-inches from center. Future work will focus on improving etches rates and etch uniformity for all three etches.

Summary of Research:

The CNF has made a conscious effort to expand our capabilities for processing larger diameter wafers. For some equipment such as the Oxford PECVD and CHA Mark 50, this is an easy switch, but for most tools, this requires much more effort. For the Oxford 100, staff must take the tool down and exchange the 100mm ceramic clamp with the 200mm clamp and adjust the alignment of the load arm.

Initial tests on etching SiO_2 on 200 mm sized wafers started with the same difluoromethane (CH_2F_2) SiO_2 etch recipe used in our HFO-1234ze(E) 2025 paper (1). Early results using this etch recipe were not promising until we returned the vacuum exhaust on the Oxford 100 from the scrubber to the tool's original path. This exhaust switch improved the SiO_2 etch rates by 20 nm/minute. We ran a two, five, and ten minutes CH_2F_2 etch and the results were consistent with a center etch rate of ≈ 96 nm/min. The 100mm CHF_3/O_2 recipes etches SiO_2 at ≈ 53 nm/min with similar etch uniformity. The selectivity to UV 210 DUV resist was 10.5:1.

Table 1: 200mm Etch Uniformity for a Ten-Minute, CH₂F₂ etch: Center of the wafer 966nm.

Distance from Center	1" from Center (nm)	2" from Center (nm)	3" from Center (nm)
North	966	933	890
South	951	921	868
West	950	927	877
East	960	915	857

Table 1.

Table 2: 200mm Etch Uniformity for a Ten-Minute, CHF₃/O₂ etch: Center of the wafer 532nm.

Distance from Center	1" from Center (nm)	2" from Center (nm)	3" from Center (nm)
North	542	509	500
South	530	521	519
West	535	543	530
East	528	509	490

Table 2.

References:

- [1] A. Windsor, J. Clark, G. McMurdy, E. Joseph, R. Syvert, R. Olson and J. Cha, J. Vac. Sci. Technol. B 43, 2 (2025).