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Characterization of Silicon Dioxide (SiO2) and Microchem S1800 Resist Etching Using Oxford 80 Plus RIE

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Summary/Description
This technical report describes the process of etching silicon dioxide (SiO2) and Microchem S1800 resist using the Oxford 80 Plus Reactive Ion Etch (RIE) system.

Disciplines
Nanoscience and Nanotechnology

Goal:

The purpose of this document is to examine the etch properties of the Oxford 80 Plus RIE system and to find the etch rate of SiO_2 and S1818 MicroChem positive resist.

Materials:

- Microchem S1818 Photoresist
- Microchem MF-319 Developer
- 4 inch Silicon Wafers

Equipment:

- Torrey Pines Scientific hotplate
- ReynoldsTech spinner
- Oxford PlasmaLab 100 PECVD
- Oxford 80 Plus RIE equipped with graphite platen
- SUSS MicroTec MA6 Gen3 Mask Aligner

Units:

- Gas flow rate: standard cubic centimeters per minute (sccm)
- Pressure: milliTorr (mT)
- Temperature: degrees Celsius (C)
- High frequency (RF) power: Watts (W)

Protocol:

Coat

1. Mount wafer and ensure that it is centered.
2. Deposit 7 milliliters of S1818 photoresist in the center of the wafer.
3. Spin on photoresist at 4500 RPM for 60 Seconds.

Soft Bake

1. Bake wafer at 130 °C for 180 seconds.

Expose

1. Use the photomask to expose the wafer at 1000 mJ/cm^2

Develop

1. Dispense approximately 150 milliliters of MF-319 developer into a six inch cylindrical container.
2. Fully submerge the exposed wafer.
3. Agitate and develop the wafer for 300 seconds.

Etch

1. Pump to 5e-04 Torr, “Pump to Pressure” checked.
2. Etch Step
   Trifluoromethane (CHF_3) flow rate: 100 sccm
   Oxygen (O_2) flow rate: 4 sccm
   Pressure: 50 mT
   RF Power: 150 W
   Capacitor starting points: Capacitor #1: 60 %, Capacitor #2: 80 %

Time set point is hh:mm:ss (hours:minutes:seconds)*
Temperature: 15 C

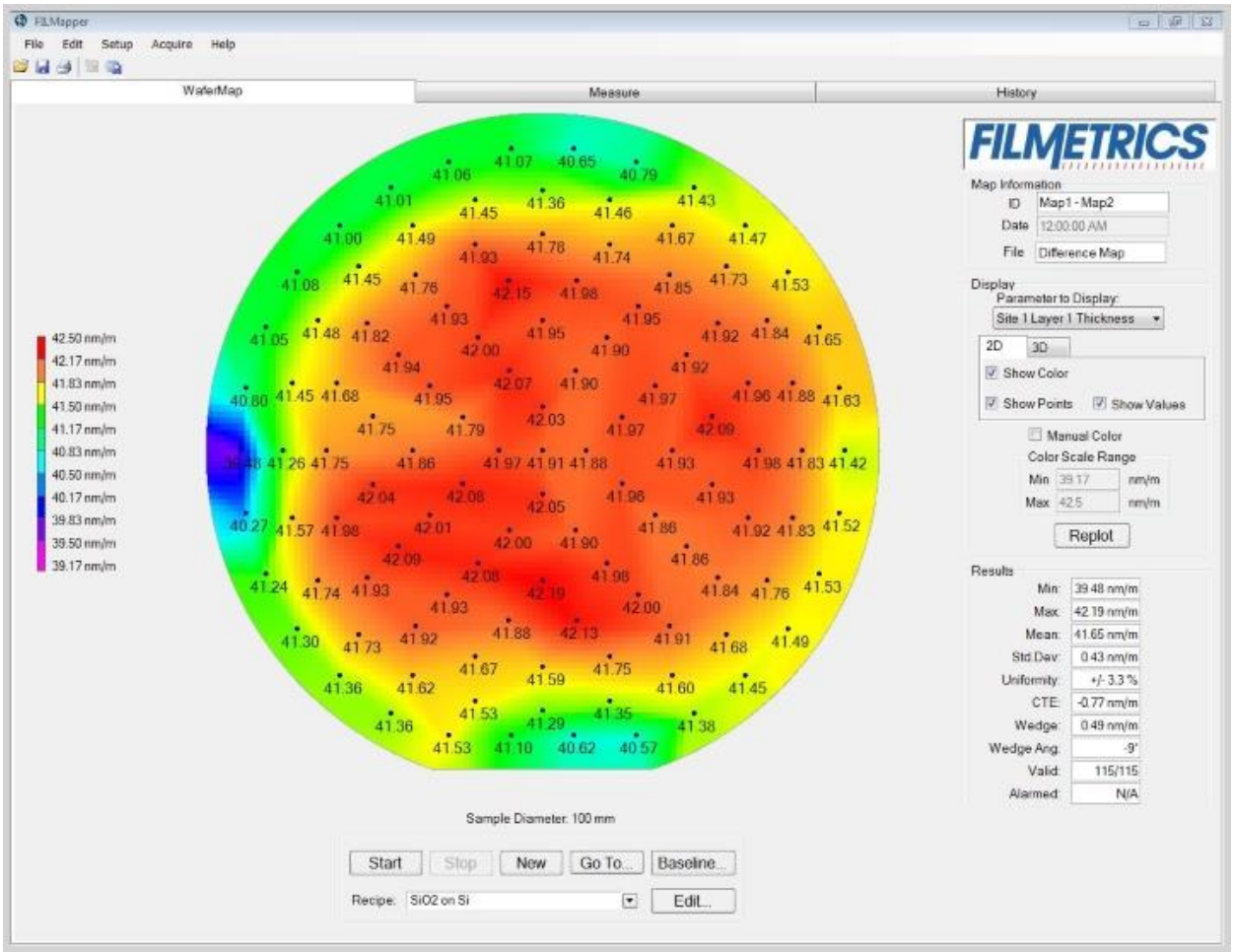
3. Pump to 5e-04 Torr, "Pump to Pressure" checked.

* NOTE: The time set point for the etch step should be kept below 10 minutes due to thermal issues and to avoid resist burning. If a longer time is needed for a thicker film then the system should be vented prior to running the process again.

Film thickness is measured using a Filmetrics F50 optical interferometer which is equipped with a motorized stage allowing for the collection of full wafer maps. See the following link for more information about this instrument: http://www.filmetrics.com/thicknessmeasurement/f50

The film being etched is PECVD SiO_2 deposited on 100 mm, <100> orientation, wafers that are 525 $\pm$ 25 micron thick.

Figure 1 below shows results for a 3 minute SiO_2 etch using the above CHF_3 and O_2 process conditions. This "Difference Map" from the Filmetrics software, using the standard SiO_2 material file, 115 data points and 5 mm edge exclusion, shows an etch rate of 42 nm/min, with a standard deviation for these measurements of 0.43 nm, and uniformity across the wafer of $\pm$ 3.3%.



The data below show the relationship between the amount of SiO_2 and Shipley S1818 remaining after etching and the etching time.

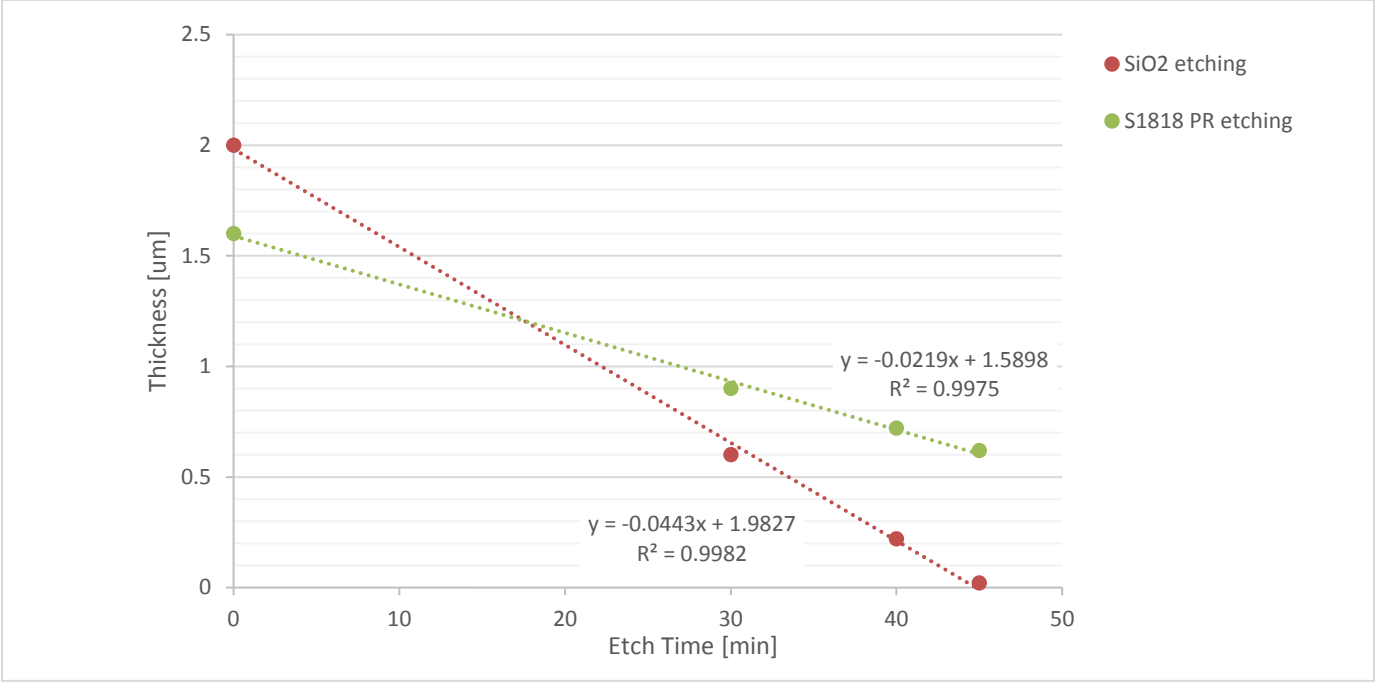


Fig. 2 – Etch rate plots for SiO_2 and Shipley S1818

The table below shows the results from the etching process:

Time [min]	SiO2 etching [µm]	PR etching [µm]
0	0	0
30*	1.4	0.7
40	1.78	0.88
45	1.98	0.98

*: The first 30 minute interval consisted of 3 separate 10 minute etches.

The selectivity of this silicon dioxide etching process to the Shipley S1818 resist can be obtained by taking the ratio of the slopes obtained from linear fits for the data series above: -0.0443/-0.0219 = 2.02