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ALD deposition of SiO2 using BDEAS and Ozone precursors

Mohsen Azadi
Singh Center for Nanotechnology, azadi@seas.upenn.edu

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Abstract

In this report, the ALD process for deposition of SiO2 using BDEAS and O3 as precursors has been studied. The etch rates and uniformity of deposition at various temperatures are reported.

Keywords

SiO2 ALD, BDEAS, Bis(diethylamino)silane

Goal:

The purpose of this document is to investigate deposition rate of SiO_2 in a Cambridge Nanotech S200 ALD system using Bis(diethylamino)silane (BDEAS) and O_3 as precursor.

Materials:

- Prime 4 inch Si wafer, single side polished.

Tools:

- Cambridge Nanotech S200 ALD
- Filmetrics F50 optical profilometer

Unites:

- Gas flow rate: standard cubic centimeters per minute [sccm]
- Pressure: Torr [Torr]
- Temperature: degrees Celsius [C]

Protocol:

ALD deposition:

- Using the Standard Operating Procedure available *here* [1] for the Cambridge Nanotech S200 ALD system, deposit 250 cycles of SiO_2 using the recipe outlined in table 1.
- Repeat the process for a full 4 inch wafer for chamber temperatures of 150, 200, and 250 C.

Thickness Measurement:

- Using the Standard Operating Procedure available *here*[2] measure the thickness and capture the wafer map on a Filmetric F50 optical profilometer.

[1] Azadi M., *Cambridge Nanotech S200 ALD standard operating procedure* (2021) Standard Operating Procedure. Book 6, Scholarly Commons, University of Pennsylvania

[2] Yamamoto H., *SOP of MET-03* (2021) Standard Operating Procedure. Book 15, Scholarly Commons, University of Pennsylvania

Table 1. Recipe details for SiO_2 deposition using Bis(diethylamino)silane (BDEAS) and O_3

0	flow	0	20	sccm
1	heater	9	250	C
2	heater	8	250	C
3	ozone flow		1	on
4	wait		300	sec
5	ozone power		1	on
6	wait		300	sec
7	wait		300	sec
8	stop valve		0	close
9	pulse	4	0.2	sec
10	wait		2	sec
11	stop valve		1	open
12	wait		1	sec
13	goto	8	50	cycles
14	wait		30	sec
15	stop valve		0	close
16	pulse	2	0.05	sec
17	wait		5	sec
18	stop valve		1	open
19	wait		3	sec
20	stop valve		0	close
21	pulse	4	0.2	sec
22	wait		20	sec
23	stop valve		1	open
24	wait		5	sec
25	goto	15	250	cycles
26	ozone power		0	off
27	ozone flow		0	off

Surface prep. steps

Deposition steps

Heaters 8 and 9, refer to the inner and outer ring of the chamber, respectively. The ozone precursor is port "4" (line 9 and 21 of the recipe table) and the BDEAS precursor is port "2" (line 16). Figure 1 shows the chamber pressure during two full cycles of deposition (lines 15 through 25 of table 1).

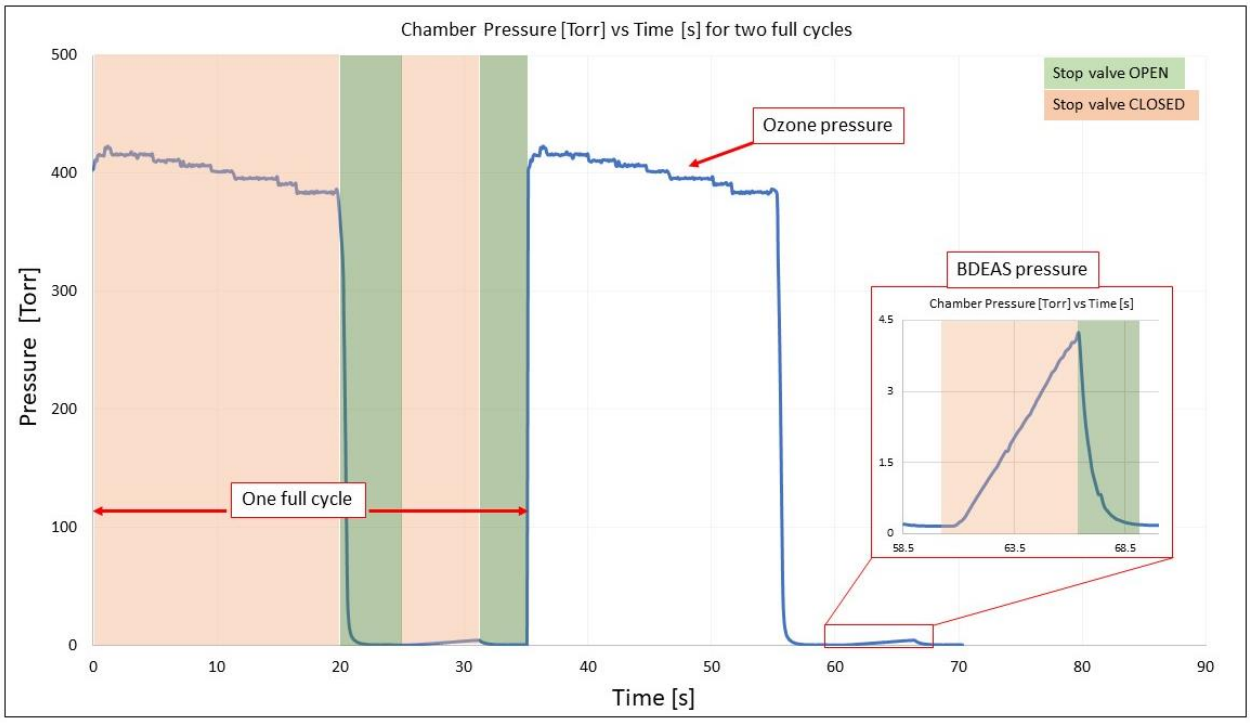

Figure 1. Chamber pressure as a function of time for two full cycles of deposition. The green and orange bands correspond to the stop valve being open and close, respectively.

Figures 2, 3 and 4 are wafer maps from Filmetrics F50 optical profilometer, for 250 cycles of deposition at chamber temperatures of 150, 200, and 250 °C.

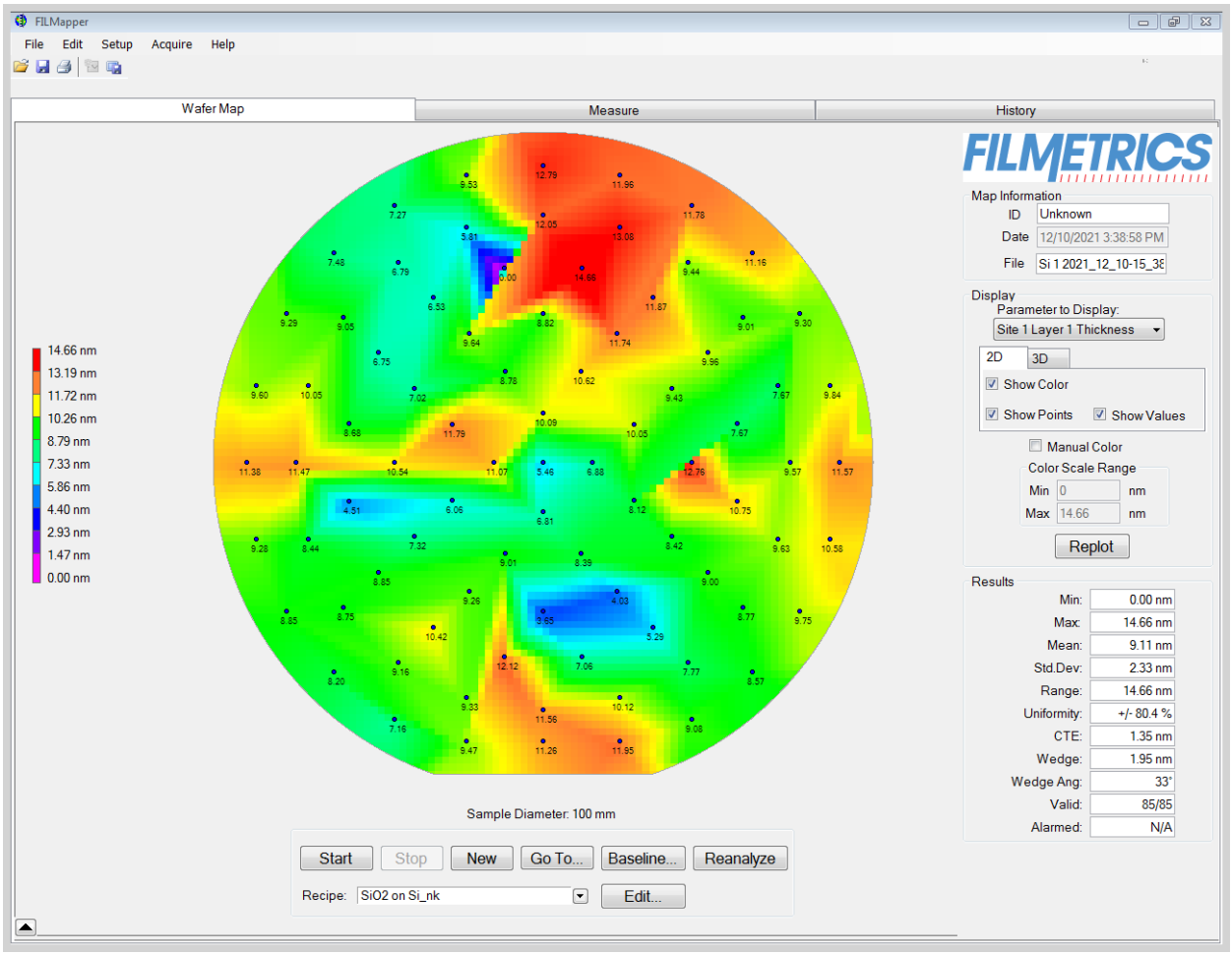

Figure 2. wafer map of 250 cycles SiO_2 deposition at 150 C.

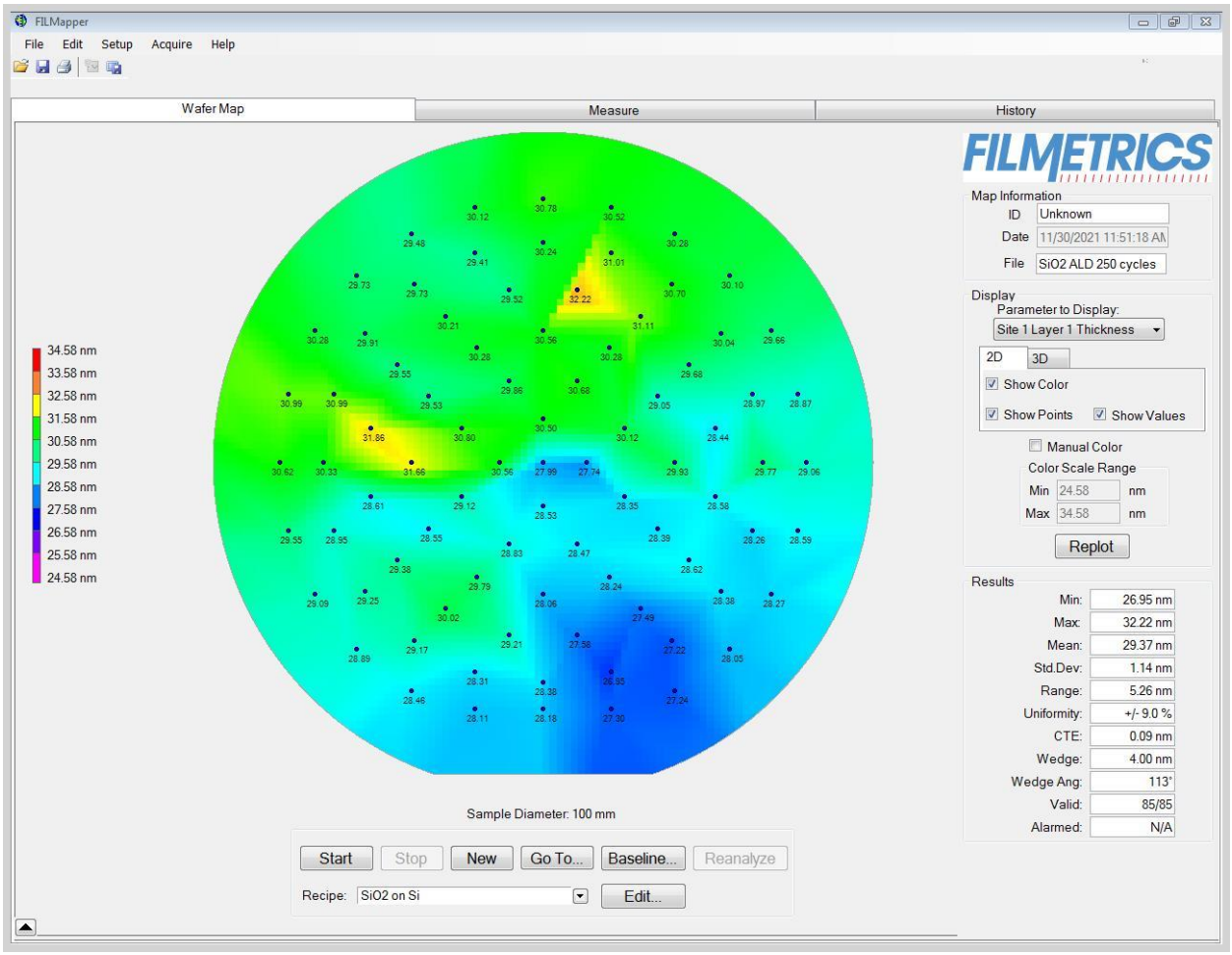

Figure 3. wafer map of 250 cycles SiO_2 deposition at 200 C

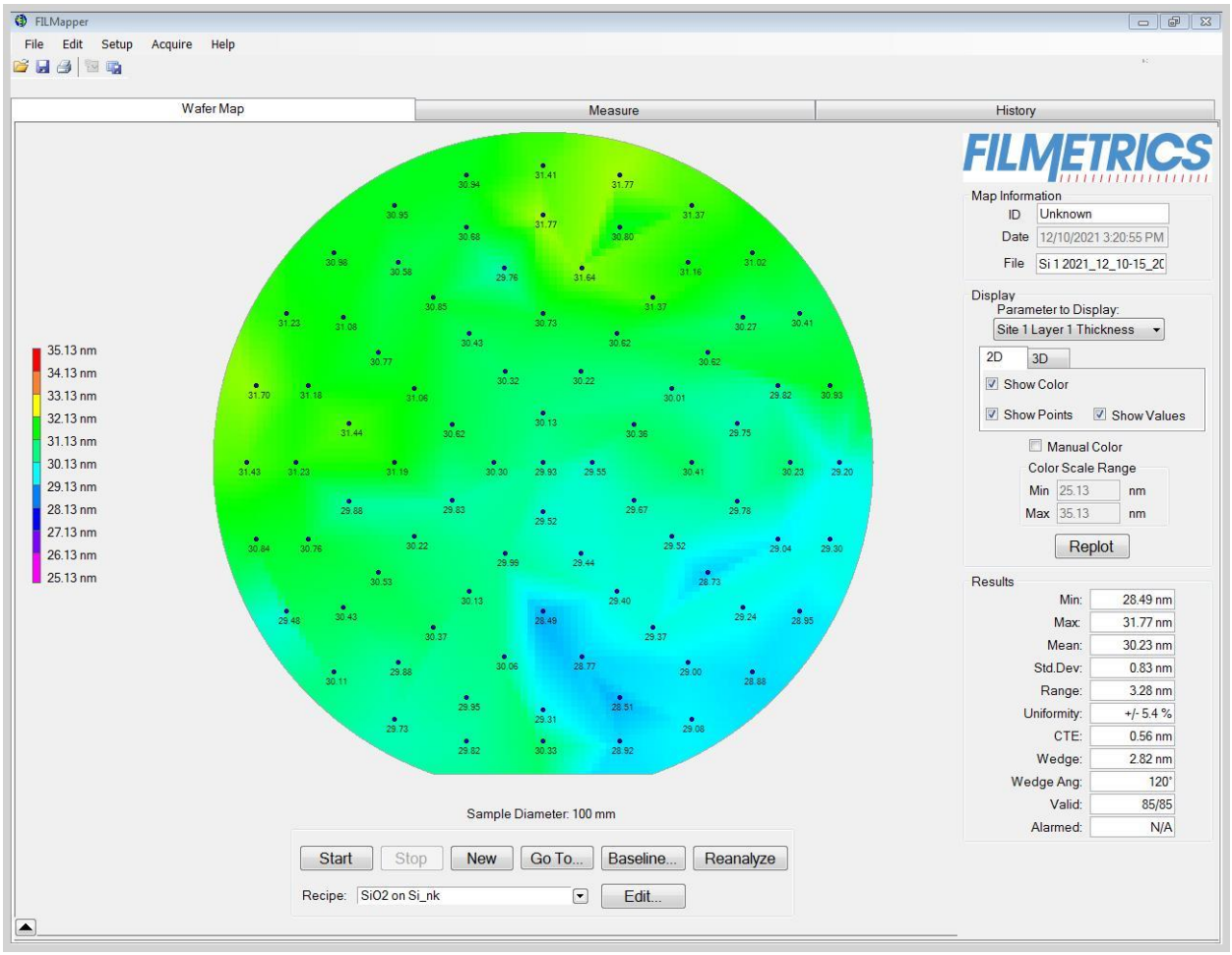

Figure 4. wafer map of 250 cycles SiO_2 deposition at 250 C

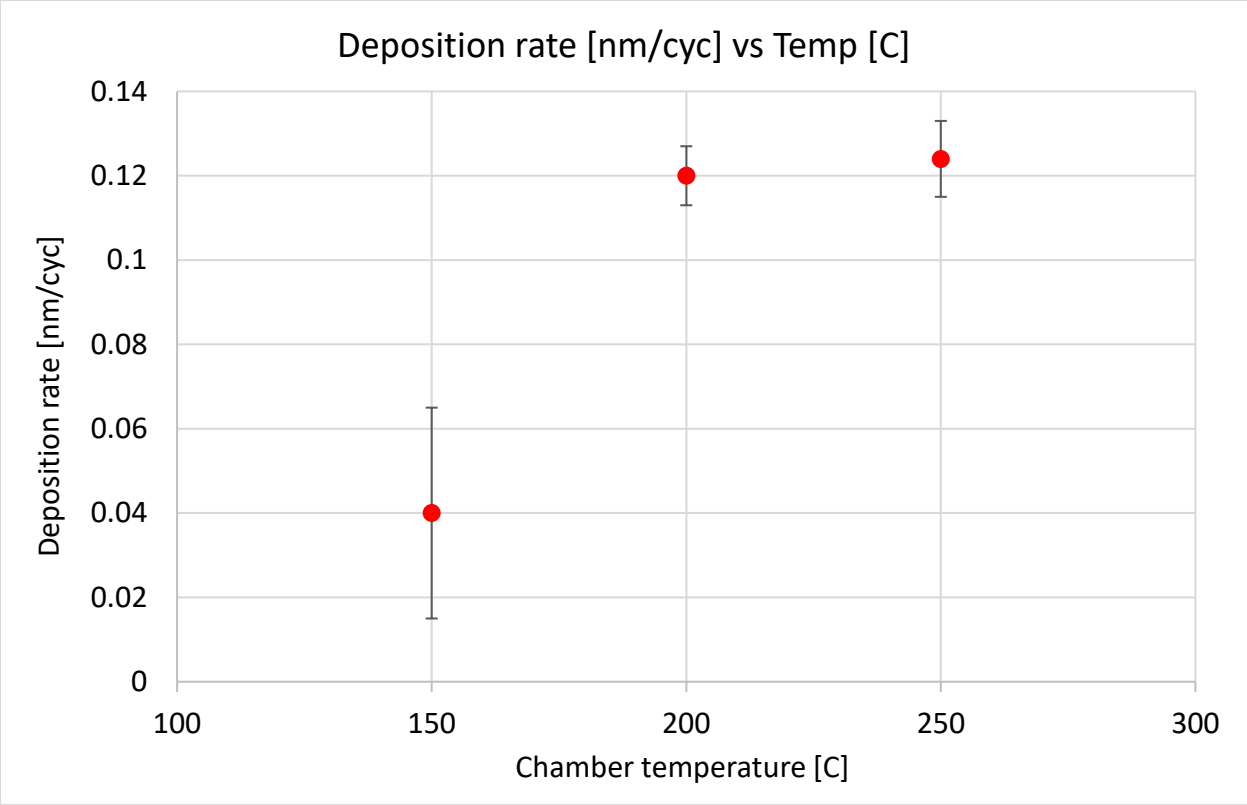

Figure 5. Deposition rate at various chamber temperatures, extracted from 250 cycles of deposition.