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Plasma Enhanced Chemical Vapor Deposition (PECVD) of Silicon Nitride (SiNx)

Summary/Description
This report discusses the deposition process of SiNx using the Oxford System 100 PECVD.

Disciplines
Nanoscience and Nanotechnology
1. Introduction

The purpose of this document is to examine the film properties and deposition characteristics of the Oxford System 100 PECVD system.

2. Baseline Recipe

Units:

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

**Step 1:** 1 minute timed pump at base pressure (below 5 mT) with electrode temperature at 350 C

**Step 2:** Pre-heat/N2 purge with electrode temperature at 350 C, N2 flow rate at 700 sccm, Pressure set point 1400 mT [set time for full 4 inch wafer is 1 min]*

**Step 3:** Deposition step with electrode at 350 C

- Silane (10 % SiH\textsubscript{4} in Helium) flow rate: 90 sccm
- Ammonia (NH\textsubscript{3}) flow rate: 45 sccm
- Nitrogen (N\textsubscript{2}) flow rate: 1305 sccm
- Pressure: 1800 mT
- High frequency RF power: 200 W, duration 12 seconds
- Low frequency LF power: 160 W, duration 8 seconds -> Transformer set to tap location labelled “500”
- “Pulsed” is checked with “HF First” also checked
- Capacitor starting points: Capacitor #1: 77 %, Capacitor #2: 26 %
- Time set point is hh:mm:ss (hours:minutes:seconds)

**Step 4:** 1 minute pump to base pressure (below 5 mT)

*notes for Step 2: if you are processing pieces mounted on a carrier substrate, it is recommended that the time in step 2 be increased to 10 minutes to ensure temperature stabilization of your samples
3. Deposition Characteristics

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

PECVD SiNₓ is deposited on 100 mm, <100> orientation, wafers that are 525 ± 25 micron thick.

Figures 1 and 2 show screen capture images from the Filmetrics software with 115 data points per wafer with a 5 mm edge exclusion. The standard Si₃N₄ “universal” material file supplied in the software is used for these measurements. This is data from two separate back to back 1 minute depositions.

Figure 1. Film thickness measurement for 5 minute SiNₓ deposition showing 256 nm deposited in 5 minutes with a standard deviation of 2.4 nm and a uniformity across the wafer of ±2.2%.
Figure 2. Film thickness measurement for a subsequent 5 minute SiNₓ deposition showing 256 nm deposited in 5 minutes with a standard deviation of 2.12 nm and a uniformity across the wafer of + 1.9%.