Chapter 5.21

Contamination Monitoring of MOS-Clean Furnaces

(tystar1 & tystar2 - 386)

1.0 Title

Contamination Monitoring of MOS-Clean Furnaces (tystar1 & tystar2)

2.0 Purpose

Proper pre-furnace cleaning is required for all runs going into any of the NanoLab furnace/s, as per guidelines specified in the pertinent Tystar lab manual chapters. An additional procedure has also been defined to further safeguard/enhance the performance of our oxidation furnaces. These are TCA or TLC (DCE) clean step prior to running the oxidation process, and regular monitoring of these furnaces by staff. The Surface Charge Analyzer (SCA) measurements (an electro-optical extension of C-V) are regularly taken on oxide monitor wafers to check the mobile ion contamination level of the furnaces (post cleaning)

3.0 Scope

This manual outlines the three steps taken to test/control contamination monitoring of the MOS clean oxide furnaces.

3.1 TCA/TLC furnace cleaning.

3.2 Growth of 300Å dry oxide (tystar1 Gate Oxidation furnace) or 2800 Å wet oxidation (tystar2).

3.3 Using SCA for contamination test.

4.0 Applicable Documents

Revision History

4.1 NanoLab Online Manual Chapter 2.6 - VLSI msink6 (MOS Clean).

4.2 NanoLab Online Manual Chapter 5.01 - Tystar1 MOS Clean Gate Oxidation Atmospheric Furnace (4" and 6").

4.3 NanoLab Online Manual Chapter 5.02 - Tystar2 MOS Clean Dry/Wet Oxidation and Anneal Atmospheric Furnace (4" and 6").

4.4 NanoLab Online Manual Chapter 8.07 - Surface Charge Analyzer (SCA).

5.0 Definitions & Process Terminology

5.1 Cleaning: A furnace cleaning process using a combination of oxygen, chlorine containing vapor [TCA: 1,1,1-Trichloroethane or TLCTrans:1,2-Dichloroethene (1,2-DCE)].

5.2 It is recommended that the dry oxidation process can be carried out immediately after the tube cleaning. Tystar1 currently uses TCA clean process, which cycles this chemical through the furnace many times over with the total recipe time of about 8 hours. Tystar2 on the other hand is set up with TLC clean process, which constantly runs this chemical through the furnace for a selected period of time with the total recipe time of about 4 hours. Both clean recipes have a build in option to delay the starting time. The cleaning recipe can be loaded with this delay the evening before, so that it will be completed by the next morning, just in time for the dry oxidation process. Please refer to Tystar1 and 2 for more details.

5.3 D_{it}: The density of interface traps (unit: number-of-traps/cm^2/ev)

5.4 IQF: Interface Quality Factor used for high quality Si/SiO_2 interface when the D_{it} is below the detection limit (dimensionless).

6.0 Safety

6.1 Do not modify any of the furnace cleaning recipes (TCA or TLC).

6.2 Follow the acid sink and furnace safety rules defined in their pertinent chapters, as well as recommendations noted in this chapter (Section 4.0).

6.3 Read the Material data sheet for the TCA and TLC posted in the lobby of the Microlab in the blue binders.

6.4 Clean recipes have to be run at the presence of oxygen, which are set up, as such in the corresponding furnace recipe/s. Never attempt running TCA without oxygen, which could generate dangerous phosgene gas ($COCl_2$, a poisonous gas).

7.0 Statistical/Process Data

Please refer to the NanoLab process monitor Data for Tystar1 and Tystar2 (on the web).

8.0 Available Processes, Process Notes

The dedicated MOS-clean furnaces and specifically the oxidation furnaces must be free of any mobile-ion/metallic contamination. Gate oxidation tubes are most critical in terms of cleanliness; therefore, special care/handing is required to ensure they are contamination free. This includes; proper pre-furnace cleaning prior to an oxidation run (TCA or TLC cleaning), as well as regular testing/monitoring of these oxidation furnaces to safeguard against mobile ion and metallic contamination/s. Surface Charge Analyzer is the tool used to test/monitor cleanliness of the MOS-clean oxidation furnaces (see Chapter 8.07 for more details on surface change analyzer theory and operation).

8.1 Tystar1 is currently set up for TCA cleaning and by selecting the **1TCA** clean recipe, members can invoke a predefined cleaning recipe on the tool (chemical is cycled in and out of the furnace for a total process time of ~ 8 hrs). This recipe has a build option to delay the starting time.

8.2 Tystar2 is set up with TLC cleaning. A high temperature process that uses trans 1, 2-Dichloroethene and oxygen at elevated temperatures (1100°C). Members can use the **2TLCA** recipe, normally enter desired process time (recommended: 1 - 2 hrs) for this TLC clean on Tystar2. The total process time should be around 4hrs, including the temperature ramp up/down. This recipe has a build option to delay the starting time.

9.0 Procedures

Furnace Cleaning

9.1 Enable the furnace to be cleaned on the WAND.

9.2 Load the TCA or TLC recipes, if you intend to use Tystar1 or Tystar2 furnace, respectively (see Process Notes in Chapters 5.01 and 5.02).

Test Wafer Cleaning and Oxidation

9.3 Check out three p-type prime (test monitor) wafers from the office. Scribe them as load, center, and source wafers.

9.4 Clean the test monitor wafers in Sink6 using the standard Piranha clean followed by a short HF dip. It is recommended to use fresh chemicals for these cleaning steps. After the wafer cleaning,

use the MOS clean vacuum wand to handle the test wafers on their backside, only- DO NOT USE TWEEZERS.

9.5 Load corresponding oxidation recipe into the desired furnace to be tested:

9.5.1 Tystar1: recipe = 1GATEOXA, temperature = 950°C for the time = hour.

9.5.2 Tystar2: recipe = 2DRYOXA, temperature = 950°C for the time = 1 hour.

9.6 Transfer the test wafers to the furnace in a clean wafer transfer box. Run the recipe and load the test wafers, in the Load, Center, and the Source sections of the furnace tube.

Contamination Measurement

9.7 After the oxidation process is finished, use Nanospec/NanoDUV to measure the oxide film thickness. Be cautious and not to touch the front side of the test wafers.

9.8 Use SCA to measure the IQF for your test wafers. You need to use the OXIDE program, and by entering the oxide thickness obtained from Nanospec/NanoDUV machines (oxide thickness should be around 300 Å for Tysta1 and 2800 Å for Tystar2). Please note, we monitor wet oxidation process on Tystar2, which grows much thicker oxide than dry oxide recipe used for Tystar1 (gate oxidation furnace).

9.9 The IQF criteria for furnace cleanness is set at 1.5 $\leq$. If the IQF is larger than 1.5, the furnace is considered contaminated. In such case, the whole cleaning process should be repeated again.

9.10 If there is no significant improvement of IQF after the second cleaning, the tube is considered grossly contaminated. Equipment and Process staff should be informed and the contamination.

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