Process 1.3

Blue & Gold Show Wafers

1.0 Process Summary

1.1 This process details a method for creating a decorative wafer pattern used for Nanolab awards.

2.0 Material Controls & Compatibility

2.1 Substrate

2.1.1 Any clean, bare silicon wafer substrate of at least test-grade quality is acceptable. Always use new wafers to begin this flow.

2.2 Storage

2.2.1 It is recommended that furnace runs load as many wafers as possible at a time for these processes. Oxide/Si3N4 stacks can be stored indefinitely prior to the lithography step. (Practical storage time is limited by rate of particulate contamination in box)

3.0 Applicable Documents

3.1 Nanolab Manuals

3.1.1 Chemical hygiene plan
3.1.2 msink6/8
3.1.3 tystar1, tystar2, or tystar3
3.1.4 tystar9 or tystar17
3.1.5 svgcoat1
3.1.6 svgdev1
3.1.7 quintel or ksaligner
3.1.8 UVBake or Axcelis

4.0 Definitions & Process Terminology

4.1 Oxide: Silicon Dioxide
4.2 Nitride: For the purposes of this process manual all nitrides are intended to be stoichiometric nitride (Si3N4)

5.0 Safety

5.1 Processing

5.1.1 Furnace processing involves severe burn hazards.
5.1.2 Several chemistries in this process can poison or harm operators. Always strictly follow equipment safety standards and CHP guidelines for wet chemistry operation.

6.0 Process Data

6.1 N/A
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7.0 **Process Explanation**

7.1 Material Stack

7.1.1 The depositions on the substrate are a two layer stack of 1000 A oxide and 2000 A standard nitride. These give a distinct blue and gold coloration to the respective layers.

7.1.2 The mask is an inverted tone mask which protects the bright spots with photoresist and exposes the areas where darker tones are desired.

7.1.3 The halftone screen converts shading to a pixelated mesh of 100% white and black spots. This allows us to use simple photolithography processes to define our image.

8.0 **Process Procedure**

8.1 Image Preparation

8.1.1 Obtain image file for show wafer

8.1.2 Load in Photoshop

8.1.3 Click Image -> Canvas Size

8.1.3.1 Select 6 inches for height and width

8.1.4 Under “add an adjustment” click “Invert” (Figure 1)

8.1.5 Click Image -> Mode -> Greyscale (Figure 2)

8.1.5.1 When prompted to discard color information, click “Discard”

8.1.6 Click Image -> Mode -> Bitmap (Figure 3)

8.1.6.1 When prompted to flatten layers, click “ok”

8.1.6.2 Choose resolution output of 450 pixels/inch (Depending on image)

8.1.6.3 Choose method - > “halftone screen”

8.1.6.4 Click OK

8.1.6.5 Choose 450 lines/inch

8.1.6.6 Choose angle of 45 degrees

8.1.6.7 Choose shape of Round

8.1.7 Note inverted mask should look like photonegative of picture – this is intentional.

8.1.8 Save file as .BMP

8.1.9 Print on inkjet printer and use inkjet transparency, rough side facing the ink. Do not use laser printer transparencies.

8.1.9.1 Note: check printer with normal paper first.

8.1.10 Attach mask to blank glass mask plate with tape.

8.2 Fabricate Show Wafer Blanks

8.2.1 Check for stored Blue & Gold Blanks – if less than 10, complete this section, otherwise move on to image patterning.

8.2.2 Clean wafers in msink8 and then msink6 with full piranha/HF treatment.

8.2.3 Load wafers into tystar2
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8.2.4 Using tystar2, run 2WETOXA with the following parameters:

8.2.4.1 Temp: 1000 C
8.2.4.2 Time: 9 minutes 52 seconds
8.2.4.3 This generates a 1000Å thermal oxide (blue)

8.2.5 Check the tystar9 monitor deposition rate and calculate required time to generate a 2000Å stoichiometric nitride film. (Roughly 60 minutes +/- 10 minutes)

8.2.6 Using tystar9, run 9SNITA.

8.2.6.1 Input your run time from the above calculation
8.2.6.2 This generates a 2000Å stoichiometric nitride film (gold)

8.2.7 You may store several “Blue & Gold Blank” wafers at this point – it is recommended to always have 10 backups in case patterning and etch encounters processing issues.

8.3 Spin Coating

8.3.1.1 Transfer 5 wafers from your Blue & Gold blanks storage to a new cassette labeled Show Wafer Blanks
8.3.1.2 Spin coat i-line resist onto your wafer blanks using svgcoat 1

8.3.1.2.1 Use process program 1 and bake program 1

8.4 Exposure and Development

8.4.1 Expose a wafer using ksaligner/quintel using monitor exposure values and inkjet mask prepared above
8.4.2 Develop the wafer with svgdev1

8.4.2.1 Use bake program 1
8.4.2.2 Use develop program 1

8.4.3 Check quality of developed pattern – Repeat above steps as necessary until developed pattern is acceptable

8.4.4 Repeat Spin Coating and Exposure and Development steps to create 5 high quality patterned wafers ready for etch.

8.5 Hard Bake

8.5.1 UV bake wafers with program A on axcelis or uvbake

8.6 Etch

8.6.1 Obtain one dummy p-type test wafer
8.6.2 Obtain one unpatterned Blue and Gold Blank

8.6.3 Load centura in following arrangement

8.6.3.1 Slot 2: P-type Test dummy wafer
8.6.3.2 Slot 3: Unpatterned Blue and Gold Blank
8.6.3.3 Slots 4-8: Patterned Blue and Gold Blank

8.6.4 Run 10 minute O2 MXP CLEAN recipe on dummy wafer to clean chamber
8.6.5 Run MXP-NITRIDE-ETCH on Unpatterned Blue and Gold Blank with a time of 60 seconds
8.6.5.1 When the endpoint system indicates a notable signal drop, end the etch manually (see centura-mxp manual)
8.6.6 Run MXP-NITRIDE-ETCH on a patterned blue and gold blank wafer
8.6.6.1 When the endpoint system indicates a notable signal drop, end the etch manually (see centura-mxp manual)
8.6.6.2 Move wafer to flat finder to check visual contrast.
8.6.7 Repeat above steps and modify endpoint timing as necessary to create visually appealing wafer.

8.7 Resist Strip
8.7.1 Strip resist in matrix for 2:30.

9.0 Troubleshooting Guidelines

9.1 Furnace Steps
9.1.1 Problem: The color of the film is not correct
9.1.2 Solution: Check deposition thickness and correct processing time appropriately

9.2 Photolithography steps
9.2.1 Problem: Mask pattern is not resolving properly
9.2.2 Solution: Examine mask under microscope with mask designer and determine if greyscale resolution needs adjustment

9.3 Etch Steps
9.3.1 Problem: Cannot resolve endpoint detection
9.3.2 Cause: Endpoint needs one wafer dummy run between cleaning and actual run to allow for seasoning of chamber. Try additional wafer, then contact process staff for assistance.

10.0 Figures & Schematics

11.0 Appendices