University of Minnesota Nano Fabrication Center
Standard Operating Procedure

Equipment Name:	Disco wafer saw		
Coral Name:	saw	**Revision Number:**	11
Model:	Disco DAD 2H/6T	**Revisionist**:	Kevin Roberts
Location:	Chase 4	**Date:**	09/17/2013

1 Description

The DISCO 2D/6HT can cut 4 inch (500 μ thick) substrates of silicon, glass, or Pyrex. Substrates that are thicker than 500 μ need a different blade and additional training. **No 6 inch substrates (needs additional training), ultra thick substrates, or hazardous substrates (i.e. GaAs, PZT….) can be cut on the wafer saw.**

2 Safety

a. **Always wear safety glasses** when operating the dicing saw! Blade spins at 30 kRPM! A blade failure can throw many sharp particles from the spindle.
b. **Do not open the saw water shield when the saw is cutting. The SEMI-AUTO button must be OFF.**

3 Restrictions/Requirements

a Must be a qualified user on the Disco wafer saw.
b. **Allowed substrates**: <u>4 inch diameter, 500 μ thick</u>: silicon, Pyrex, glass, sapphire. <u>500μ-1mm thick</u>: silicon, Pyrex, glass – with permission and additional training. **Not-Allowed substrates**: 6 inch substrates, ultra thick substrates, hazardous substrates (i.e. **GaAs, PZT**)
c. Enable/Disable the saw in CORAL with each use. You must be enabled in Coral when cooling the wafer saw.

4 Required Facilities

a. Compressed air, 80 psi (minimum 72 psi)
b. Chilled water, 1.6 GPM
c. DI Water
d. vacuum, -22 in. Hg

5 Definitions

<u>Mounting:</u>

Substrates must be mounted on tape if they are cut all the way through. NFC has 2 tapes that are available for users. The tape must be placed tightly on the mount. No gaps or sagging areas can be on the tape. Sagging areas will affect the height of the cut. Stick the tape to the back of the substrate. Avoid getting bubbles between the tape and your substrate. Bubbles will increase the depth of your cut.

Blue Tape: (P/N: 18074 – 9.00); Thickness: 75 μm : This is used for the mounting of substrates that are going to be cut all the way through. This tape has medium tack and should only be using for cutting out devices that are least 1cm x 1cm. Small die may fall off this type of tape.
Set the Z height for 0.060mm when using this blue tape.

Clear UV tape: (P/N: UC-120M-120); Thickness 120 μm : This is used for the mounting of substrates that are going to be cut all the way through. This tape has high tack and should only be used for cutting out devices that are smaller than 1cm x 1cm. The tape will need to be exposed on the ORIEL for about 5+ minutes to release the adhesive (Be sure to place the sample under the ORIEL lamp with the tape-side up).
Set the Z height for 0.090mm when using this clear UV tape.

Spacer: The spacer goes on the spindle shaft first, when cutting with a standard silicon dicing blade (with built-in blade hub). This is to compensate for optical mis-alignment when changing from hub-less blades to blades with a built-in hub.

Blades/Flanges: See the Disco Saw Blades and Flanges section on the last page.

Kerf: This is an estimate of cut width. It can vary slightly depending on different variables. See the Disco Saw blades and flanges section on the last page for more info on this, and to read how Kerf differs with each dicing blade used.

Maximum Cut stroke (diameter) is 150 mm.

Terms used for rotation:
CW: Clockwise turn.
CCW: Counter clockwise turn.

6 Operating Instructions

Enable the SAW in CORAL.

INITIAL COOL-DOWN:
1. Turn on cooling water (2 orange knobs)
2. Turn on DI water for blade (black knob)
3. Turn on vacuum (black knob on right side of DI water valve).
4. Turn on **Auto Breaker** for power (right side). **Standby** light should be lit if adequate air pressure is available (> 72 psi). Machine will be in **Mode A**, **FIX/VAR** light will be lit. These are the default modes and they are the correct modes.
5. Press ***PROG # 1.***

Mandatory!

Wait 15 minutes for the cooling water to cool all parts evenly before proceeding, or the stainless spindle may bind with its bronze lining inside the air bearing (0.0005" tol.)

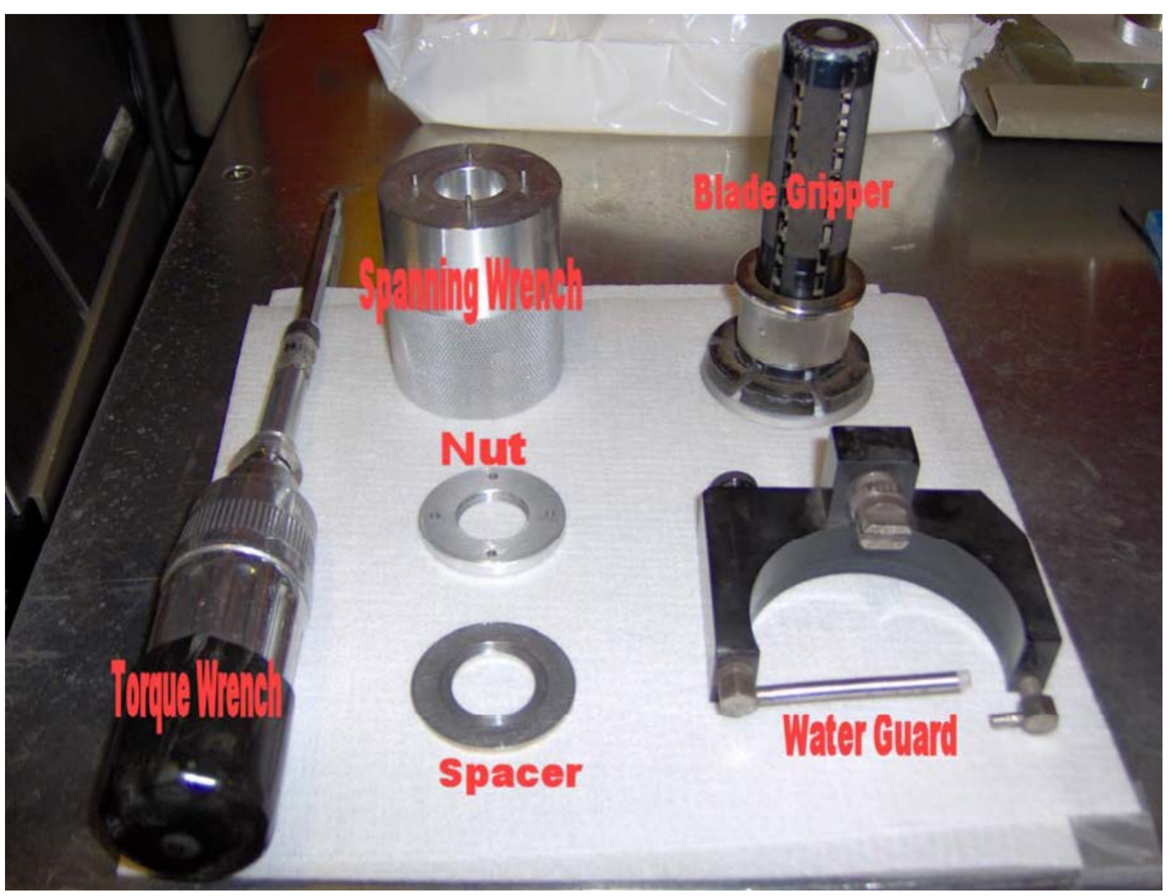
Spindle Check

Press ***REPEAT,*** and the Y-axis down arrow ↙ to move the spindle all the way to the front of the machine.

Turn spindle manually to test that it spins freely. If it does not spin freely, DO NOT USE the saw. Contact a staff member, and/or shutdown the machine in the Coral system.

Loading a new Blade

There are several of tools and parts needed to change blades on the saw. A blade gripper, spanning wrench, nut, a torque wrench, and a spacer (depending on the blade used). You may also need a small wrench to adjust the water jets (located under the saw machine).

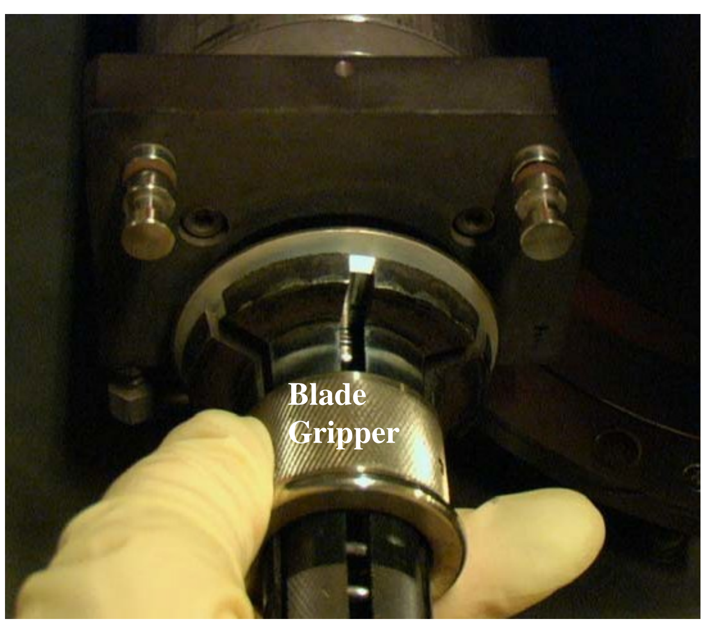


Put on the spacer if needed then the appropriate blade that will cut your substrate. Aluminum hubs (fixed hubs) may leave deposits on the steel spindle. Clean this marring off (if any) with Isopropanol and a clean room wipe to aid in putting on a new blade.

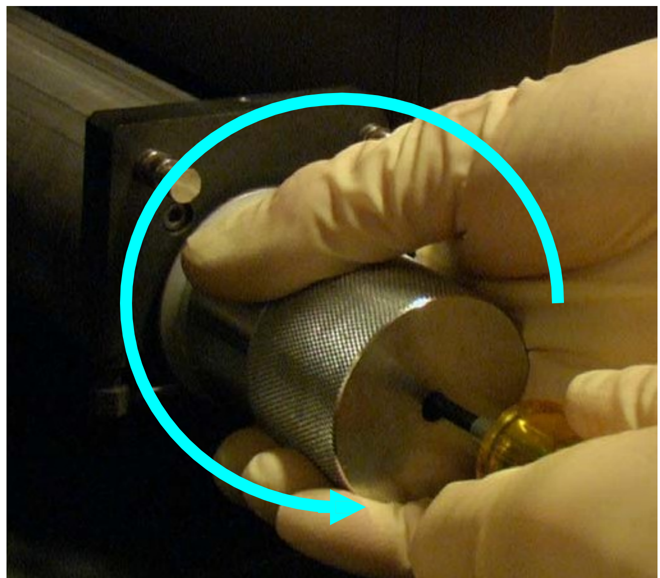
The standard 4 inch silicon dicing blade that has a built-in hub needs the spacer. The spacer should minimize any optical alignment that needs to be done so that various blades are close to the same position on the shaft. Blades without a built in hub (like the glass or sapphire dicing blades) do not need the spacer.

Inspect your blade. If the blade is nicked or especially worn get a new blade. There needs to be enough blade exposure to cut through your substrate without hitting the hub part of the blade. You should never cut to the maximum exposure of the blade. If you hit the hub during a cut you could damage the spindle.

Find the correct blade/flange to use, if necessary use the spacer. Attach the new blade or blade/flange and put it on the axle of the spindle assembly. Make sure the blade is flush to the spacer or the front of the spindle. It should not wobble when you turn the spindle.

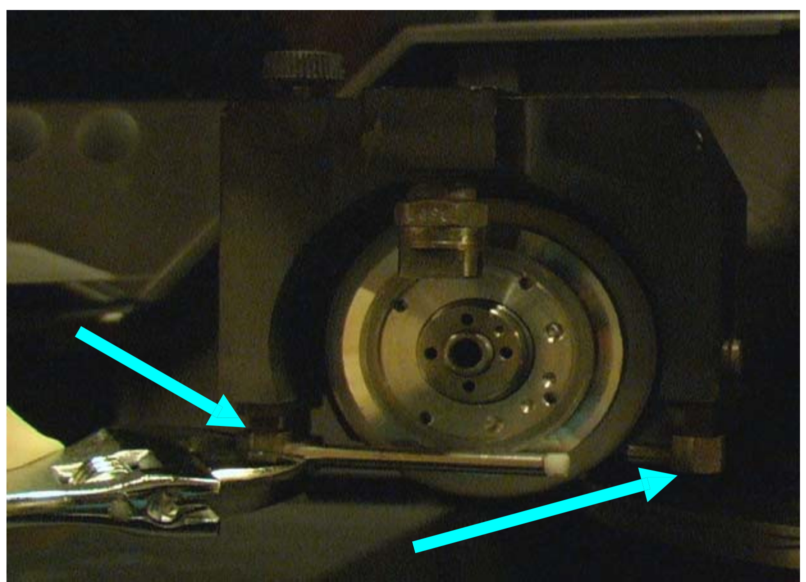


Using the spanning wrench and the torque wrench attach the nut to the spindle assembly and tighten by turning Counter Clockwise. Once the spanning wrench is tight turn it until the torque wrench clicks.



Re-attach the water guard. Spin the blade to verify it turns smoothly.

Adjust the water jets so they do not touch the blade and that the water will flow evenly over the blade.



Press ***REPEAT*** then the y-axis up arrow ↗ to move the spindle assembly all the way to the back of the saw.

Machine Set up

1. Press ***SPINDLE*** to ramp up spindle. If the sound during ramp up is not typical contact a staff member. Do not continue to use the saw. Any sound other than the spindle ramping up in speed may indicate a problem.

2. Press ***VACUUM***.

3. Press ***SET UP*** for chuck zeroing of the blade. Note that the blade will touch the chuck itself. Setup light will light if all is well. If you get '**error**' displayed, chances are you forgot to turn on the vacuum. Clear the error with the *SHIFT* key.

4. Press ***ILLUMINATION*** for microscope lights. Green dots should be visible. Turn on Video Monitor and CCTV camera power if needed.

5. **CUT-STRK** (cut stroke, i.e. diameter) light should be lit. If not, press *SHIFT* until it is. Press ***C/E*** to clear old parameter value. Press ***1*** for 'Block' value. Then press ***100*** for 100 mm diameter wafers. For smaller pieces enter the appropriate dimension. Press ***W*** for 'write' to save the values.

6. Press ***SHIFT*** to advance to **CUT-SPD** (cutting speed in mm/sec). Press ***C/E*** to clear **CUT-SPD.** Press ***9*** *(for 4mm/sec – standard speed for 4 inch silicon).* Press ***W*** for 'write' to save the values. You can easily jog through the speed options by pressing the +1 CUT SPD -1 buttons accordingly. Other speeds might be desired and/or necessary for different substrates. Ask an NFC staff member for assistance.

7. Press ***SHIFT*** to advance to **Y-IND.** There will be two Y-IND to enter, Block 1 and Block 2. Block 1 is for the CH1 set point, and Block 2 is for the CH2 set point (this determines the spacing of the cut while in this block/channel). The machine shifts between blocks 1 and 2 whenever a 90 degree rotation occurs. Press ***C/E*** to clear old values. You can enter a number like 10+ mm for both Blocks (temporarily-- while moving the microscope lights to your first desired cut location). Press ***W*** for 'write' to save the values.

8. Press ***SHIFT*** to advance to **Z-IND** (Block 1). Press ***C/E*** to clear old value Enter *0.060 or 0.090* mm for samples to be cut on either the blue or uv tape. **Press *W* for 'write' to save the values. If your sample is NOT to be cut all the way through or is greater than >550 microns contact an NFC staff member for assistance.**

9. Press ***SHIFT*** to advance to **Z-IND (block 8).** Confirm it is on 2.000 mm. If not, set it to *2.000* mm.

10. Press ***SHIFT*** to advance to **θ-IND** (Block 1 only). Set to *90* degree for 90 degree rotation.

11. Press ***SHIFT*** to advance to **CUT NO**. This isn't important in **'SEMI-AUTO'** operation. Set it to 1 if it is not already.

12. Press ***SHIFT*** to advance to **CUT #**. This is a counter which displays how many cuts have been completed in your run. Set it to *0* by pressing *C/E.*

13. Press ***SHIFT*** to advance back to **Y-IND** (in case you want to change these values after positioning the microscope lights to your starting location). You are done with parameters for now. You can always use ***SHIFT*** to check values again, and change them if needed.

Loading and Cutting

1. Mount your wafer onto tape using the wafer holder. If your substrate is only partially being cut, tape is not needed. A different chuck needs to be used for the saw. Contact an NFC staff member for assistance.

2. Press the X-axis → button to move the stage farthest to the right.

3. Press ***Vacuum*** to turn the vacuum off to the machine. Load your wafer holder being very careful not to hit the moving blade. The narrow side of the wafer holder goes in first. There are magnets on the chuck to hold the wafer holder down. Make sure the piece is centered onto the chuck. This is important so as not to break the blades.

4. Press ***VACUUM*** to turn the vacuum back on. Gauge should go to the green position.

5. System should be in ***REPEAT*** mode. If not, press ***REPEAT*** to index in 10 mm steps (or whatever you chose for the Y-IND values). Get close to your first desired cut location.

6. In ***REPEAT,*** or ***JOG SCAN*** mode, use ↙ ↗ or ← →or θ- rotation buttons to align the workpiece to the alignment crosshairs. Your wafer needs to be aligned before cutting. In JOG SCAN mode, use ↙ ↗ to move the cross hairs to cutting position. Your first cut should be on a practice wafer or an area on your wafer where you do not care where the cut is located.

7. Close both water covers. Press ***SEMI-AUTO*** to start water, then press the up or down arrows ↙ ↗ (This will choose which direction the cuts will index—towards you or away from you), and then press ***SEMI-AUTO*** for a single cut. Adjust water to ~1.2 l/min. **After the cut is done, blow the water off and adjust the optics alignment on the saw so the cross hair and cut mark line up (only if it is not already lined up)**. Now you are ready to continue to cut your wafer.

8. Align your wafer to the crosshair where the cut should be made (i.e. in the middle of a scribe line). If your devices are evenly lined up in rows and columns the **Y-IND** can be adjusted so once the first cut is done the saw will continue to cut in evenly spaced rows.

9. Press ***SEMI-AUTO*** to start water, then press the up or down arrows ↙ ↗ (This will choose which direction the cuts will index—towards you or away from you), for multiple indexed cuts or as mentioned previously, you can press ***SEMI-AUTO*** -then ↙***or*** ↗- and de-select ***SEMI-AUTO*** for a single cut.

10. Check that your Y-IND is a correct value, by looking in the microscope and pressing REPEAT several times, assuring the crosshairs line up with each row to cut.

Never leave the SAW unattended while using.

11. Once done cutting in one direction you can cut in the perpendicular direction by pressing the ***ROTATION*** button and either the ***CW*** or ***CCW*** buttons. The chuck will rotate 90 degrees. If desired, you can realign you wafer but it is not necessary for most applications. Line up the crosshairs to where you want to cut.

12. Press ***SEMI-AUTO*** to start water. Adjust water to ~1.2 l/min. Press ↙ ***or*** ↗- to start cutting. The saw will continue to cut either in the up or down direction until stopped. The cut spacing will be the distance set in **Y-IND (the next block)**. To stop the saw cutting press ***SEMI-AUTO.***

Removing Your Substrate

1. Press ***REPEAT*** and ↗ to index move the blade to its furthest back position. Press → to move stage to farthest right position. Blow water off sample with nitrogen gun.

2. Press ***VACUUM*** to release vacuum on chuck. Wait until gauge reads low vacuum. Remove tape frame from chuck.

Shutting Down the SAW

1. Press ***SPINDLE*** to ramp blade down. Allow it to come to rest before proceeding.
2. Unload the Blade
   Remove the water guard. Take the wrench and remove the outer nut of the blade assembly. Hold the wrench with one hand and the torque wrench with the other. Turn Clockwise to loosen the nut. Take the blade/hub off using the blade gripper. Put the spacer away (if you used it). Remove any non standard blades and or flanges. Return them to their proper containers.
3. Press ***ILLUMINATION*** to turn microscope lamps off.
4. Switch ***AUTO BREAKER*** off.
5. Close left water lid. Leave right side open to facilitate drying.
6. Shut off video monitor and CCD camera (if used).
7. Turn off vacuum valve line (black handle to the right of the DI water valve).
8. Turn off DI water (black handle).
9. Turn off cooling water (2 orange knobs).
10. Disable the SAW in CORAL.

.

7 Appendix

Calculate the distance between 2 points.

1. Go to the starting point (where you want the cut to go).

2. Press ***DATA SEL*** then ***press 1***. This will set the counter to O. Press ***JOG*** then either up or down arrow to the next point you want to cut. The value displayed on the screen will be the distance between the 2 points.

3. Press ***SHIFT*** until you get to the ***Y-IND***. Clear out the old value and input the new distance. Remember to press '***W***' to write the value.

4. Check the distance be pressing ***REPEAT*** and the up or down arrows before starting your cut.

Recommended Feed Rate (speed)

Silicon : 3-4 mm/sec for 500 µ thick silicon.

Glass: 1.0 – 2.0 mm/sec for 500 µ thick glass or Pyrex.

Sapphire: 0.5 0 – 0.80 mm/sec for 500 µ thick sapphire.