DISCO DICING SAW SOP

April 2014

INTRODUCTION

The DISCO Dicing saw is an essential piece of equipment that allows cleanroom users to divide up their processed wafers into individual chips. The dicing saw uses a diamond blade that allows it to cut through very dense materials. The dicing saw is ideally suited for wafer designs that utilize Manhattan geometry, but is also capable of lining up and making individual cuts. This SOP will cover normal use of the machine, but the last section will also cover how to replace a blade if one is broken. This can occur at any time, so reference that section if breakage does occur.

GETTING STARTED

The first step with working with the DISCO will be to supply compressed air to the system. Turn on the air valve above the machine located in the following picture. This will require you to climb a ladder. The valve is off whenever the handle is turned perpendicular to the flow of air. Turn the valve so that it is open and air is flowing to the machine as shown here:

![Air Valve Image]

After that, we will turn on the water. Water flows over the blade as it is making a cut and it is used to cool the area. Without water flowing the machine will run, but it will melt the blade very quickly. It is very important to make sure water is flowing before the blade makes contact with
anything. The valve is located to the right of the table next to the hydrogen generator here and is shown turned on:

Next, we will supply power to the machine by turning the key on the front of the machine to the **START** position before letting it rest at the **ON** position. Also, it is advisable to reference the **Sample Preparation** section and turn **ON** the wafer mounting station so that it will get up to temperature by the time you need it.
Lastly, press the INITIALIZ button on the keyboard when prompted by the system. This will home the microscope and the processing chuck so we can move forward.

**BLADE PREPARATION**

Before we can begin dicing, we have to go through a few steps to make sure that the machine is provided with accurate information about our blade. Press the F5 key to access the Blade Maintenance screen.

Press F3 followed by F4 to bring up the contact sensor. The contact sensor is a sequence of two processes designed to verify the current height of the blade. The machine will first lower the blade to make contact with the edge of the chuck. This verifies that the machine is able to read when it is encountering resistance. The next part of the sequence will move the blade to the back sensor and move up and down through the sensor. This will detect where exactly the outer edge
of the blade is and will alarm if there is significant enough deviation from the expected value. Press \textbf{ENTER} to get the blade up to speed, and then again to start the test.

If the amount of wear is significant, the machine will fault out and demand that you update the blade information. To change this information, first record the magnitude of error at the bottom of the screen when the alarm goes off (e.g. \(x = -0.033\)). Go to the \textbf{Blade Replacement} screen and change the outside diameter by this much (e.g. if the old diameter was 58.000mm,
the new diameter would be **57.967mm**. Go back and perform the sensor calibration setup again if you do change the diameter value. If the alarm does not go off then you are ready to proceed to blade dressing.

BLADE DRESSING

Press **EXIT** twice to get back to the blade maintenance screen. From here we will hit **F5** to begin the blade dressing process. This process allows us to make a single cut along a dressing...
board to clean the blade and ensure that it is cutting in a straight line. **LOAD** the dressing wafer (located above the machine) onto the chuck, making sure that the two slots on the top of the metal ring make contact with the raised screws on the chuck.

Once the sample is in place, press the **C/T VAC** button on the keyboard. This will activate the vacuum on the chuck and will ensure that our sample stays in place. Adjust the display by rotating the light level knob (located next to the display) and the microscope focus knob (located on the right side of the microscope assembly). Then use the up and down arrow keys (next to the shift button) to adjust the location of the view to just above the last cut performed on the dressing board previously. After that, make sure that the water valve above the machine is open. If it is, press **ENTER** to make a single cut in the dressing board.

![Image of dressing board and machine](image)

After the cut is made, the microscope will move into place so we can examine the cut. If the sample is too wet this will be difficult, so use the nitrogen gun located just underneath the keyboard to blow water off the dressing board. The screen should be pretty well lined up with the cut here, but if it is not then use the up and down arrows again to adjust accordingly. When this area is lined up, press **FS** to move to the other end up of the dressing board and line the screen up with the cut here. This is to ensure that the machine is cutting in a straight line and any minor changes in angle are compensated for. Press **ENTER** to set the change in angle, and then press **EXIT** until you make it back to the main screen.

Press **INITIALIZE** to release the vacuum on the sample and return it to the top of the machine.
Press the **F4** key while on the *Main Screen* to access the *Recipe Setup* screen. It will take you to a screen where you can select which recipe you want to use or modify. There are many recipes here, but most are unused now so feel free to modify any that look to have not been used recently. Once you highlight a recipe and hit **ENTER** the machine will ask you for a password. Make sure that the **SHIFT** key in the lower right of the keyboard is active and then enter the password. The password for all recipes is **MEMS14**.

Once you enter the password you will be greeted by a screen similar to the one above. Here we are setting the parameters for our dicing job. Although there are many fields here, I will go over only the ones that may need changing:

- **Cut Shape** – Press the **F1** key (**make sure the shift key is not on**) to change this between square and round, depending on the shape of your sample. Changing this will adjust what can be modified in the work size field
- **Work Size** – This field is used to determine the total size of your sample. If your sample is a circular wafer and you have chosen round for the cut shape then you will input the wafer diameter here. If your sample is rectangular then you can input the side lengths if you have chosen square in cut shape. It is advised to set this larger than your sample to compensate for the fact that you may not have placed your sample perfectly centered. There is potential for damaging the blade if it plunges into a surface from above instead of coming in from the side.
- **Blade Height** – This determines the distance away from the chuck the blade will be cutting. This will almost always be at a minimum of 0.08mm (*the thickness of the blue tape*). For small chips it is advised to leave 50–100um of substrate uncut. This will prevent chips from flying off during cutting but will allow the user to easily break them apart along the diced lines just using their hands.

- **Feed Speed** – This is the speed at which the blade moves across the surface. For a 500um Silicon wafer it is advised to go no faster than 4mm/s. For denser substrates such as glass you will normally want to be below 1mm/s.

- **Y index** – Here you are setting the street-to-street distance of the cuts in the two directions. Ch1 will be defined as the distance between the horizontal streets as you first loaded the sample, Ch2 is the distance between the vertical streets. If these distances are unknown, they can be measured by pressing F8 and using the on screen readings.

**SAMPLE PREPARATION**

In order to use the dicing system we have to suspend our wafer in blue tape held by a metal ring. To do this we are using the nearby blue tape system:

![Image of sample preparation](image)

Turn **ON** the heat to the system by using the switch located on the back side of the machine. This will turn on a LED on the front side to let you know it is heating. The heat will help our sample bond with the tape so there is less of a chance that it will slip off while it is dicing. The green chuck will heat relatively slowly and will take about 20 minutes to get to the idea temperature. You want the chuck to be hot enough that you can touch it, but not leave your hand on for more
than couple seconds. Make sure not to leave the blue tape system running too long (more than an hour) or it has the potential to damage itself.

Once the chuck is up to proper temperature then place your sample face down on the center of the chuck. The orientation doesn’t really matter, but try to orient it so that the dicing streets are aligned vertically and horizontally. Take one of the metal rings located on top of the machine and place it around the green chuck making sure to follow the outline for how it lines up.

Pull the blue tape over the wafer to the other side and leave it suspended over the wafer. Take the small rolling pin and use it to press the blue tape against the wafer. Roll back and forth to remove all the air bubbles from the wafer. Extend your motions to press the blue tape against the metal ring. Once everything is pressed down flip the switch located on the front left of the machine to turn on the vacuum. This will pull the blue tape very tight against the sample. If it does not immediately pull the tape tight there is probably a pathway for the air to escape so make sure that the tape is pressed down as completely as possible.

Once the tape is vacuumed onto the sample we are ready to cut the tape. Move the large metal framework down over the chuck. Use the outer edge of the framework as a guide and drag one of the nearby razor blades across the metal sample ring to cut the blue tape. Remove the excess tape from the top and bottom of the metal ring and turn off the vacuum. Remove your sample by slowly lifting the metal ring while taking care that the sample does not come off. Once removed, flip it over and it is ready to go onto the Disco chuck.

**DICING SAMPLE**

Once you have finished setting up the recipe you are ready to begin dicing. First mount your sample on the blue tape if you have not already done so. Then move it over to the machine and place it on the chuck the same way you placed the dressing wafer earlier.

Depending on your sample, you will want to run the machine in one of two modes: Automatic or Semi-Automatic.

**Automatic mode** is to be used for designs that have a consistent Manhattan geometry to the dicing lines. Automatic mode will allow the user to select a single street in the two different directions and will then process the whole wafer based on the streets you selected and the offset you programmed into the recipe.

**Semi-Auto mode** is used for wafers that are not using consistent spacing between cuts or if you don’t want to dice an entire wafer. Semi-Auto mode allows a user to select a street and then select how many cuts to do based on the offset in the recipe. Setting the cut number to one will allow you to align each cut individually. The process for the two modes is nearly identical with
the only significant difference in semi-auto mode being the number of cuts, the button press to perform alignment, and the button to start the sequence (press the key correlated to BACK to make subsequent cuts move towards the back of the machine).

Press F1 when you are on the main menu to begin the run sequence for the recipe that you have loaded onto the machine. You will be greeted with a screen similar to this one:

![Image of a computer screen](image)

First you will want to use the controls on the right side of the keyboard to locate the streets of your sample like we have in the picture above. Once you have aligned your street in the dotted lines you will probably notice that it is not totally orthogonal. We can fix that by hitting F5: ALIGN THETA. This will move the camera to a corresponding spot on the other half of the wafer. Use the keyboard to align the street in the same way you did before. Hit F5 again to lock in this adjusted theta value. You can repeat this process as many times as you need to until you are satisfied.

Once you have fixed the theta make sure that your street is within the dotted lines. These dotted lines represent where the blade will cut (assuming the blade is a 200um wide blade). When you are satisfied press the index button on the right side and press up and down on the keyboard. This will jog the stage to where it expects the subsequent cuts to go. If these are not aligned to your streets you will have to properly modify your recipe. When you are satisfied and you are focused on any one of your streets hit enter. The system may ask you to jog the stage, if so just quickly hit the Y up direction on the keyboard and hit enter again. The stage will rotate 90 degrees and allow you to select the street in this direction the same way you did before. Be sure
to use the index button again to make sure the street-to-street distance is what you expect. Press enter when you are satisfied here and the machine will prompt you to hit START/STOP to begin cutting and the screen will change to something like this:

![Machine screenshot]

The important things to notice while the machine is running are highlighted here. The red circle shows what step the dicing recipe is currently on. The machine in this case is making the first of seven cuts in the current direction. Once it has finished those cuts it will rotate 90 degrees and begin making the cuts in CH2. The blue circles show an estimate of how much time it will take to complete the recipe. In this case the current time is 18:55 and it predicts finishing at 19:02 so we have seven minutes until it is completed. At any time during the dicing you can press START/STOP to pause the sequence after the current pass to examine your sample or ZEM to emergency stop and immediately stop the blade.

When the recipe is finished an alarm will sound. Silence that alarm with the ALRM CLR button. Press EXIT to go back to the main screen and press INITIALIZE to deactivate the vacuum and allow you to retrieve your wafer. If you are finished, turn the KEY ON the front of the system to off and shut off the compressed air and water valves above.

**BLADE REPLACEMENT**

Blade replacement is necessary whenever a blade breaks or you want to switch to a different thickness blade. This is also the screen you will use if the diameter is wrong during the initial blade setup. Access the Blade Replacement screen by pressing F5 then F1 from the main screen.
The first thing we want to do here is to adjust the values for the blade we are putting into the machine. The values can be determined from the label on the replacement blade container. The settings above show the values for a common 250um blade. You are only required to change the **Blade O.D.** (Outside Diameter) and the **Blade Thickness**. The outside diameter will gradually deteriorate as the blade is used so it may be necessary to come back to this screen to change it if you are getting errors in the Blade Setup step. Stay on this screen while you manually change the blade.

To change the blade, make sure that the water is shut **OFF** on top of the machine, but leave the air on. Open up the large glass window next to the stage. The blade is located behind the grey
shield, so reach underneath it and pull it up towards you. This should allow you to see the blade. Find the torque wrench usually located on the top of the machine.

Use the torque wrench (#3 in the picture above) and fit it into the mount of the blade (#2 in picture above). The large post should fit in the center of the mount and the smaller posts around the edges should fit into corresponding holes in the mount.

Turn the torque wrench until the mount comes loose from the blade holder. Remove the mount and place it to the side. Use the tool usually on top of the machine to remove the blade holder as in the following picture:

If the previous blade was broken, remove all debris from the mount using the nearby sink. If the blade was intact then simply remove it (carefully) and place it back in the correct container for that type of blade. Make sure to mark the container with the updated Outside Diameter that was on the screen so that the next user has an easier time when replacing the blade again. Once the holder is clean, take the new blade out of its container and place it on the holder. It can sometimes help to get the blade and/or holder wet so that it sticks better to the holder.
With the blade in place, simply repeat the steps backward. Use the device to hold the blade holder and slide it back into place. Be careful that the blade doesn’t fall out or that you don’t damage it by bumping into something. Next use the torque wrench to tighten the mount until you hear the torque wrench click. Move the shield back down and close the glass lid. Run through the Blade Setup sequence and you are ready to begin dicing.