GENERAL PROCESS AND OPERATION SPECIFICATION

Disco Dicing Saw Model DAD3241

I. SCOPE

A. This document describes the basic operating procedure and necessary requirements of the Disco Model DAD3241 Dicing Saw. It will also include instructions on how to mount samples onto tape and metal tape rings using the Wafer Tape Applicator, which enables full-depth cuts on samples without damaging the wafer chuck.

II. SAFETY

A. Be sure that you have been trained and signed off on using this tool.

B. Be sure to close both doors to the machine before operating the equipment or activating the saw blade spindle.

C. Be sure to always wear safety glasses when operating this tool.

D. Contact a staff member if you are unsure of the operating procedure for this tool, or if any unknown errors are encountered.

III. APPLICABLE DOCUMENTS, MATERIALS, AND REQUIREMENTS

A. For more information about the operation of this tool refer to the 'Disco Dicing Saw Operation Manual,' located both in hardcopy near the Wafer Tape Applicator and online on the AggieFab website.

B. Please contact a staff member for assistance in changing broken or worn saw blades.

IV. OPERATION

A. <u>Check which blade is currently installed.</u>

i. Z09 blades for silicon samples (silver), R07 blades for glass samples (yellow/gold), and KR15 for sapphire samples (black). Blade packages are in the tray located in front of the tool. An empty package indicates that the blade is currently installed in the tool.

ii. If dicing bonded wafers, use the blade suited for the hardest material in the stack.

iii. **If the blade installed in the tool is not adequate for your sample, contact an AggieFab staff member to change the blade. Staff: please make a cut on the hairline alignment wafer afterwards and perform the alignment (Section K)**.

B. <u>Preparing and Mounting Samples.</u>

i. Turn on the Wafer Tape Applicator machine and prepare a sample to be diced.

ii. Open the lid of the Applicator, and the metal tape ring should already be placed on the machine's table.

iii. Place your sample in the middle of the metal tape ring.

iv. Turn on the blue pump below the table, then turn all switches on the front console of the machine.

v. Draw the tape out from the topmost edge of the applicator table. Stick the tape to the bottom most edge of the applicator table.

vi. A thin, clear film will be separated from the tape and collected in a roll above the rear of the Applicator. Using the black wheel attached, draw the film away from the sample.

vii. Flatten out the tape using the rubber roller, then close the lid.

viii. To cut the tape away from the main roll, slide the black knob located one of the topmost corners of the table across the top edge. To cut the excess tape away from the sample, push down the black knob on top of the lid and circle the table twice.

ix. Open the lid of the Applicator and peel away the excess tape. Turn off all switches on the front of the Applicator. Turn off the blue pump. Then,

remove the mounted sample. See **Figure 1**.

C. Prepare Dicing Saw for Use.
   i. Start the iLab session for the Disco Dicing Saw.
   ii. Once the display turns on, the Disco saw application should already be running.
   iii. Make sure both doors of the tool are closed before pressing 'System Initial' (which resets the position of the wafer chuck and dicing blade.
   iv. Open the right door of the Dicing Saw and place the mounted sample onto the wafer chuck such that the upraised bars at the top of the chuck align with the divots on the top of the metal wafer tape ring. The sample should be on top of the tape, with the adhesive side of the tape facing up.

D. Performing Hairline Alignment
   i. Hairline alignment tests and measures the thickness and alignment of a cut while specifying spindle revolutions, feed speed, etc. I**t is strongly recommended to perform hairline alignment at the beginning of each dicing session to recalibrate the blade position and confirm that the Kerf width meets your requirements.**
   ii. Press 'C/T Vacuum' to hold the dummy wafer in place by engaging the chuck table vacuum.
   iii. The machine will force you to perform hairline alignment after making the first cut with a newly installed blade. To trigger this purposefully, select 'Blade Maintenance' (F4) from the main menu, then 'Hairline Alignment.
   iv. Change the parameters within the 'Hairline Alignment' menu appropriately, including spindle speed and feed speed.
   v. Press 'START.' Once the cut has been made, use 'Widen Hair' (F11) and 'Narrow Hair' (F5) to adjust the crosshairs to sit at the center of the cut. Press 'ENTER' when done. If the machine complains in the top status bar about the size of the adjustment, press 'ENTER' again.
   vi. For silicon samples using a 35 µm blade, the expected Kerf width is approximately 45-55 µm. If the actual Kerf width significantly exceeds this range, it may indicate blade damage, please contact AggieFab staff for blade replacement.

E. Edit Recipes
   i. Enter the 'Device Data' menu (F3) to open the recipes directory, select the recipe you would like to modify, then press 'ENTER'
   ii. To create a new recipe, highlight the '12 TRAINING' recipe located in the 'USER_RECIPES' folder. Select 'Copy.' Under the dropdown menu select 'USER_RECIPES,' and assign any random number in the yellow input box. Select this new recipe, and press 'ENTER.' To rename, locate the 'ID' section to change the title.
   iii. See **Appendix A** and **Figure 2** for information about the recipe parameters.
   iv. Please see **Section I** and **Appendix B – Depth-Steps Function** if you are cutting sapphire or borosilicate glass.
   v. Please see **Section J** and **Appendix B – Chopper Function** to make smaller cuts of a given length on your sample, and contact a staff member for guidance when creating a chopper function recipe.

vi. Press ‘ENTER’ to save changes to the recipe.

F. Align Sample for Dicing

i. Navigate to the main menu, then select ‘Manual Operation,’ (F2) then ‘Cutting SemiAuto’ (F4)

ii. Select ‘Manual Align’ (F4) to begin the focusing and alignment process.

iii. Navigate to an identifiable, horizontal, and straight pattern on the sample. Select ‘Focus’ (F9) then ‘Auto Focus.’ (F9) The measured work and tape thickness will be displayed on the right of the screen. **If your sample is thicker than 1.0 mm, you must keep in mind that you must perform partial depth dicing (section H).** Press ‘EXIT’ when done focusing scope.

iv. Align sample using two points:

1. Find a **straight** horizontal pattern or edge on the sample with which to align the cutting path. Use the fine adjustment scrolling to aim the crosshairs at this pattern, and then press ‘Align θ,’ (F6)
2. The machine will move the crosshair far from that point. Move to a different point on the same pattern or edge in another part of the sample, then press ‘Align θ’ again once the crosshairs are aimed at the second point.
3. The sample should be automatically straightened in preparation for dicing. The cutting path is now parallel to the line formed by the two points you selected.

v. Place the crosshairs at the location which you would like the first cut to be. Press ‘ENTER’ when done.

vi. Three techniques to dice the sample are outlined below in Sections F, G, H, I, and J. **If dicing a sample thicker than 1.0 mm, see Section H to make partial depth cuts. If dicing a non-silicon sample, see Section I.**

G. MULTIPLE CUTS (regular cuts)

i. In the ‘Cuts’ section of the recipe in the ‘Device Data’ menu, set the number of cuts for each channel. (setting 0 will make all possible cuts within allowed workspace)

ii. In the Semi-Automatic Cutting menu, make sure ‘Cut line’ is set to 0.

iii. Choose the direction in which the dicing saw will index:

1. Align the crosshairs at either the topmost or bottommost edge of the sample.
2. If at the top of the sample, select ‘Front’ (F12). ‘Front’ places each subsequent cut in front of the last, towards the observer.
3. If at the bottom of the sample, select ‘Rear’ (F6). ‘Rear’ places each subsequent cut behind the last, away from the observer. Press ‘START.’

iv. After the machine is done, dismiss the alarm by pressing ‘Alarm/Cir’

v. If the saw blade was changed in preparation for your sample, the machine will force you to perform “hairline alignment” after it has made the first cut with the new blade. See **Section K** if this occurs.

vi. You can make more cuts, or press ‘Ch +’ to rotate the chuck.

vii. If there is a straight edge or pattern now aligned **horizontally** after rotating the

chuck, you may align the sample again using the method in **Section D**.

viii. Select either 'Front or 'Rear', then press 'START' to make the second dimension of cuts.

H. INDEX CUTTING (irregular/manually positioned cuts)

i. In the 'Semi-Automatic Cutting' menu, make sure 'Cut line' is set to 1. This means the tool will make a single cut at a time, allowing you to move the cursor manually before each cut.

ii. Use the scrolling functions of the scope display to align the crosshairs at the cut you would like to make.

iii. Select either 'Front' (F12) or 'Rear' (F6) (it doesn't matter which when 'Cut line' = 1), then press 'START.'

I. PARTIAL DEPTH DICING (required for samples > 1.0 mm thick)

i. Edit the recipe so that the 'Blade height' exceeds 0.090 mm, which is the thickness of the tape.

ii. **If you are dicing a sample thicker than 1.0 mm, you must set the blade height to at least 0.200 mm to avoid the tool causing scratch marks on the surface of your sample.**

iii. After alignment (see **Section E**), in the Semi-Automatic Cutting menu, select either 'Front' or 'Rear' and then press 'START.'

iv. Cuts can be made using the methods of both **Sections F** and **G**.

v. After partial depth cuts have been made and your sample is removed from the tool, it is easy to manually snap away the rest of the cut, since most materials will fracture evenly once a fault line has been drawn.

J. DICING HARDER SAMPLES (sapphire and glass)

i. Contact staff regarding making a blade change. Sapphire samples must use KR15 blades, glass samples must use R07 blades, and silicon samples use Z09 blades.

ii. When creating a new recipe, use the recipe 'SAPPHIRE_GLASS_TEMPLATE,' located in the 'Device Data' menu, as a template.

iii. The recipe must include a 'depth steps' function, which makes multiple passes over each cut, lowering the blade height in by the value of 'depth steps' until the target depth is reached. See **Appendix B**.

iv. Change the "Work thickness" to the approximate thickness of your sample.

v. Change 'Depth steps' under CH1 and CH2 to the desired step height between each pass.

vi. For sapphire samples, make 4-6 passes per cut. For glass samples, make 1-2.

vii. Press 'ENTER' to save changes, and proceed with methods in **Sections F, G, H**.

K. MAKING CHOPPER CUTS (small cuts, non-index)

i. Making small, precise cuts around a pattern requires the use of a chopper function in the recipe. Consult **Appendix B** on how to modify a user recipe to include the correct parameters.

ii. Within the recipe, be sure to select either 'A_CHOP' or 'A_UP_CHOP' as the Cut mode.

1. 'A_CHOP' cuts from left to right, 'A_UP_CHOP' cuts from right to left.
2. Without doing this, the tool will cut the entire sample index.

iii. When making only single cuts, make sure that Cut line is set to 1.

iv. Navigate to the 'Cutting Semi-Auto' menu. Before making a cut, select 'Manual

Align' (F4) and complete the steps in **Section E** to line the sample up correctly.

1. The X-offset parameter in the recipe will determine how far from the crosshairs the cut will start from. The X-length parameter in the recipe will determine how far the blade travels once it has reached its target depth.
2. The sample MUST be re-aligned using the method in **Section D** before making each chopper cut.
3. If when attempting 'Single CH Alignment' in Channel 2, the program keeps reverting to Channel 1, this is caused by exiting the Cutting Semi-Auto menu and changing the recipe in between channels. To avoid this, make all chopper cuts within Channel 1 first, then change to Channel 2 and continue with alignment without leaving the menu.

v. Select either 'Front' or 'Rear', then press 'START.'

L. <u>Unloading Sample and Powering Off tool</u>

i. Press 'System Initial' to return the chuck and sawblade spindle to their original positions.
ii. Make sure the spindle is not rotating. Doors will not open if the saw is active.
iii. Press C/T Vacuum to disengage wafer chuck vacuum, then remove sample.
iv. Power off the machine by ending the iLab session.

V. SIGNATURES AND REVISION HISTORY

A. Author: Sharanya Shivani, Student Technician
   i. Date: 16th August 2023
   ii. Revision: A
   iii. Updates: Revised Appendix A, added Appendix B, added dicing for sapphire, blade change instructions, hairline alignment, making chopper cuts

B. Author: Anton Fedotov, Student Technician
   i. Date: 8th October 2024
   ii. Revision: B
   iii. Updates: Removed blade change instructions (see AggieFab Staff Handbook), added clarifications on when hairline alignment is necessary, specifications for thicker samples (>0.900 mm), details about theta alignment, other verbiage changes for clarity.

C. Author: Yu Chen, Research Engineer
   i. Date: 21th April, 2025
   ii. Revision: C
   iii. Updates: Refined Section D to clarify the importance of performing hairline alignment at the start of each session, detailed the manual procedure to initiate Hairline alignment, included expected kerf width range for silicon samples using Z09 35 µm blades.

Approvals:

Technical Manager Signature: Sandra Malhotra

Date: 4/22/2025

Revision History:

Revision	**Author**	**Date**
Original Issue	S. Shivani	6/26/2023
Revision A	S. Shivani	8/16/2023
Revision B	A. Fedotov	10/8/2024
Revision C	Y. Chen	4/21/2025

Figures

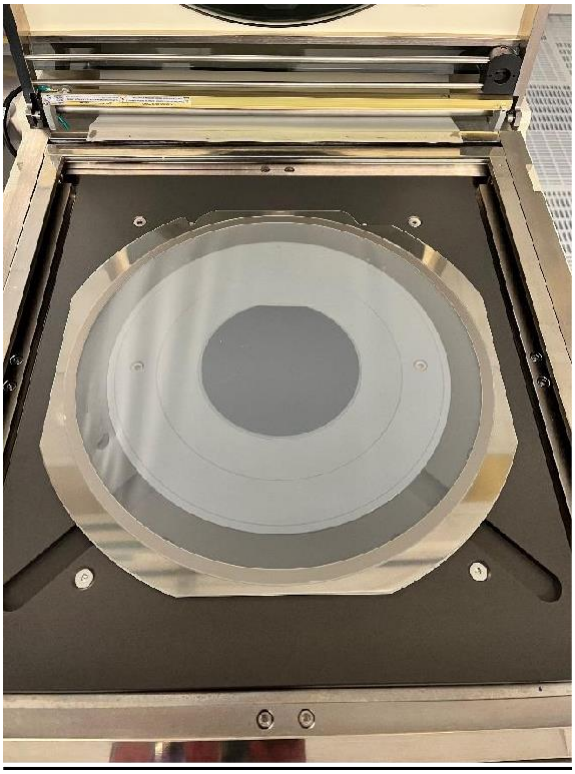

Figure 1: Mounted sample in Wafer Tape Applicator machine with excess tape removed.

Figure 2: Device Data menu with parameters in millimeters.

Appendix A: 'Device Data' parameters and descriptions

Recipes can be edited by entering 'Device Data,' selecting a recipe or copying anew recipe, and the program can further be modified in the Cutting Semi-Auto menu,

ID = **USER TBD**. Rename the recipe under the USER_RECIPES directory.

Work shape and size: **USER TBD.** Round samples have DIAMETER input, Rectangular/Square samples input length and width in mm.

Spindle rev. = 30,000 rev/min recommended for silicon samples, use a spindle speed of 15,000 rpm or less for harder samples

Work and tape thickness = **USER TBD**. Use 'Measure' (F10) then 'Focus' (F9) then 'Auto Focus' (F9) to find the approximate thickness of the sample and tape. **You must use the depth-steps function (described in Appendix B) if your measured work and tape thickness is >1mm.**

Tape thickness = 0.090 mm

θ Deg. = **USER TBD**, 0° and 90° for rectangular

pieces. Cut mode = A, A

Cut dir. = REAR, REAR

Cut = **USERTBD**. (If making all possible cuts in the work shape, enter 0 lines, otherwise specify the number of cuts to make)

- USE SEQ1 for both channels.

Blade height = **USER TBD**. Default is 0.060 mm above the wafer chuck for full depth dicing, will cut 0.030 mm into the mounting tape. If your sample is thicker than 0.9mm, you must increase blade height so that it cuts 0.9mm or less into the sample.

Feed speed = **USER TBD**. Default is 20, which works well for both silicon and glass samples. Decrease to 5 when dicing sapphire samples.

Y-index = **USER TBD**. In Ch.1 and Ch.2 SEQ1, the size of the dice in mm. Ch.1 will cut horizontally relative to the original position of the wafer, Ch.2 will cut horizontally after rotating the wafer chuck.

After editing the recipe, select 'ENTER' to save changes.

Appendix B: 'Device Data' special function parameters

Specialized functions and their parameters can be added to a recipe in the 'Device Data' menu. While editing the recipe parameters, select 'Function Selection' (F4) to view a list of functions available for use.

Depth-Steps Function

- Function is used to incrementally decrease the blade height until the target blade height is reached.
- Is a requirement to dice harder samples (sapphire and borosilicate glass)

Depth steps = **USER TBD**. The maximum interval for which the blade height decreases per pass. Calculate this approximate height by making 4-6 passes for the hardest samples (sapphire), and 2-3 passes for glass and others.

Chopper Function

- Function is used for making small cuts away from the major indexes. Using this method requires 'Manual Alignment' before making each cut.
- The minimum length of cut possible varies depending on the total sample thickness and the target blade depth. It is best to run tests on the sample to determine this length before making cuts.
- Due to the circular nature of the sawblade, areas on the periphery of the chopper cut may not have reached full target depth. These areas need to be carefully carved further using a razor or small knife.

Cut mode: **USER TBD**, set to either 'A_CHOP' or 'A_UP_CHOP' when making small cuts.

Z down speed: **USER TBD.** Default speed is 0.100 mm/s for relatively clean cuts. The speed at which the blade lowers over the part to be chopper cut.

X-offset: **USER TBD**. When set to 0, the sawblade will navigate to the location of the crosshairs and lower to the specified blade height. X-offset is the distance from the crosshairs that the blade will navigate to.

X-length: **USER TBD**. The distance the sawblade will travel once it has lowered to the target depth. When set to 0, the full length of the cut of a sample with thickness 0.600 mm (due to the circular saw blade) is approximately 9.78 mm. Input any additional length past this point for the necessary length of cut to be made.

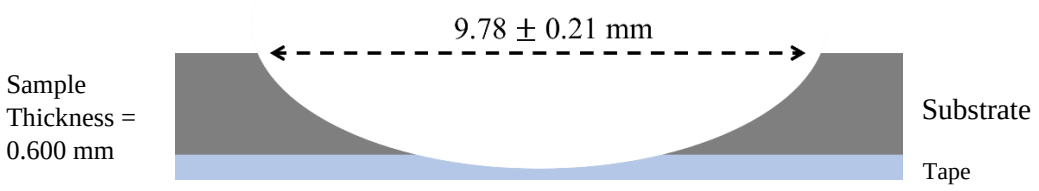

Figure 3: Diagram showing smallest possible chopper cut cross section at a blade height of 0.06 mm.