



DJ MICROLAMINATES, Inc
Dry Film Sheets
490 Boston Post Rd
Sudbury, MA 01776
Tel: +1 (978)261-3188
e-mail: info@djmicrolaminates.com

Improved Preliminary Lamination Guidelines

Do not lay the SUEX™ sheets directly on the substrate and then laminate
The SUEX™ must only contact the substrate at the junction of the rollers

Note: Thin SUEX™ TDFS are fragile and must be handled gently. Do not pick up sheets with the fingers or tweezers while flat, use the full hand or multiple fingers (wearing cleanroom gloves) or better yet a large plastic or metal spatula with a non-stick coating. When transporting single sheets it is best to pick up the sheet and hold vertically while handling. The corners of square or rectangular sheets are particularly prone to breakage and need to be handled with extra care. We also recommend that the TDFS be stored overnight and laminated in the cleanroom at a temperature of 20-22°C (68-72°F). Higher cleanroom temperatures will make void-free laminations more difficult as the TDFS will tend to stick to the wafer and entrap air pockets at the wafer surface. Lower temperatures make the films more brittle.

The laminator we recommend is the [SKY 335R6 Laminator](#), which can be found on [amazon.com](https://www.amazon.com).

Hot Roll Laminators With Support Sheet

We recommend that the substrate be placed on a well supported carrier sheet on the lamination equipment and the SUEX™ sheet be aligned and supported above the substrate on a 125µm (5mil) PET sheet or overhead transparency.

1. Set the laminator rollers to the desired temperature and let it warm until a steady temperature is reached. For simple laminations to a bare substrate use a temp of 60- 65°C. Please contact us for specific recommendation for more complicated structures.
2. Place a 12"X12" (300mmX300mm) support sheet (we use 0.5mm thick (19Ga) mill finish aluminum sheets) or a 8.5-12" X 12", 5mil (125µm) thick PET support sheet on a flat platform in front of the laminator. If you use a 5mil PET sheet you may need to increase the temp by 3-5 °C. This is to be used to support the resist and wafer during the lamination and protect the laminator rollers from possible extruded resist. Keep this at least 1"/2.5cm away from the hot rollers until ready

to laminate. We typically use an upper protective sheet of 5mil (125 μ m) thick PET to protect the upper roller from the SUEX™ resin which may be extruded out during the lamination process. This is particularly necessary when you are doing exploratory work at higher temperatures. It is generally more convenient to tape the top of the cover sheet to the carrier sheet by taping it over an edge onto the backside of the carrier sheet.

3. OPTIONAL SHIMS: Attach a half inch by 3inch (1cm X 8cm) piece of 22mil (560 μ m) adhesive backed polyethylene sheet towards the front of the support sheet and parallel to the front edge of the sheet leaving enough room behind the guide to fit the entire substrate on the support sheet. It is highly recommended that a second guide strip be placed just behind the back of the substrate to prevent it from sliding backwards during the lamination. Additional guide strips along the sides of the substrate may also be employed. Thicker guides will be required when laminating sheets thicker than 200 μ m to eliminate movement of the TDFS as it enters the laminator rollers. Ensure that the thickness of the guide strips is always less than the total thickness of the substrate and the TDFS (including the 50 μ m coversheet which is left attached for the lamination).
4. Make sure that the roller speed is set as desired and run the laminator until the protective PET sheet is just under the laminator rollers. Stop the rollers and fold the protective PET back over the roller assembly. We recommend a speed of 0.75 ft/min (0.2m/min) to 1.25 ft/min (0.5m/min) but we typically run at 1 ft/min (0.3m/min). You will need lower temperatures at the slower speed to keep the resin from melting and higher temperatures at the faster speed to get proper lamination.
5. Take the wafer or substrate to be laminated and place it face up on the support sheet with the flat (if present) to the front facing the laminator and in contact with the PE guide.
6. Place a clean sheet of 2 mil (50 μ m) or 5 mil (125 μ m), non-stick PET which is larger than the wafer on top of the substrate with a flat edge approx 1/2 to 3/4 in (1.5 – 2cm) behind the wafer flat or leading edge of the substrate. Standard laser grade overhead transparencies (PET) typically work well but test first as different grades of PET have different adhesion characteristics. We typically use a large sheet of the clear PET coversheet and will be happy to supply a few samples. The sheets can be reused multiple times unless they become contaminated.
7. Place the SUEX™ sheet to be laminated on a rigid, flat surface. Use a small piece of Scotch 600 Transparent Tape (or other similar sticky tape – magic or invisible tape will generally not work) and press it firmly at the outer portions of the film and over the outer edge of the TDFS. We usually attach it at one of the corners of

the wafer flat. Make sure that it is firmly attached to the edge of the PET coversheet. Carefully lift the tape until the corner is detached from the resist sheet. Either PET surface can be removed first but we prefer to remove the clear sheet first as the residual hazy sheet will serve as a reminder that there is something covering the resist surface.

8. Pull the tape back (not up) over the TDFS making sure that the coversheet is being removed as you pull the tape. Keep the SUEX™ laying firmly on the rigid surface. The coversheet should easily release from the resist surface. If not, press the tape more tightly to the very edge of the TDFS. Throw away the removed coversheet.
9. Carefully pick up the TDFS, turn it over and place it on top of the non-stick PET sheet with the open resist surface facing down, but do not push the two resist surfaces together. Center the SUEX™ TDFS within the boundaries of the substrate as well as possible keeping the wafer flat and the sheet flat. Do not contact the TDFS to the wafer until ready to laminate.
10. Turn on the rollers and insert the carrier sheet into the rollers leaving the protective top PET sheet folded back over the roller assembly. Do not touch or move the wafer, the TDFS or the non-stick PET sheet. With thicker sheets it may be necessary to hold the TDFS/PET/substrate securely so that it feeds between the rollers and does not get pushed back off of the substrate. It is best to hold it at the back edge of the substrate supporting the arm or hand onto the moving carrier sheet being careful not to move or twist the non-stick PET. The thicker the SUEX™ sheet the more likely it is that the rollers will want to push it out rather than pull it into the laminator. As noted above a thicker shim is recommended with the thicker SUEX™ films.
11. Make sure that the PET sheet remains flat and does not wrinkle as it is being fed into the laminator and that the protective PET is pulled into the laminator and not allowed to fall on top of the TDFS until it is fully within the laminator.
12. Once the wafer feeds into the rollers let it feed naturally. Once the non-stick PET has moved to approx 1/4in (1cm) of the roller stop it from moving by holding it gently with the fingers and continue to hold it in place behind the rollers until the entire substrate has fed into the laminator. The the non-stick PET can be removed and the protective PET allow to fall onto the carrier sheet.
13. After the stack has feed through the laminator let it rest on the exit table for 15-30 sec to cool, then lift the laminated substrate off of the support sheet.

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14. OPTIONAL Post Lamination Bake (PLB): Bake the laminated substrate with the PET coversheet still in place on a leveled hot plate, TDFS up, at 80-90°C for 5-30 min to give improved substrate contact and an improved surface appearance.
 15. The laminated substrate can now be stored until needed
 16. When ready to use, remember that **the laminated SUEX™ sheet will still be covered by a PET coversheet which needs to be removed** before processing.
 17. The support sheet can be cleaned with acetone, if necessary, and reused as needed for as long as the surface remains smooth and clean.

Vacuum Lamination

Vacuum Lamination can be performed on a vacuum laminator, a wafer bonder, a hot polymer embossing press or a vacuum press. We recommend that a blank wafer be placed on the bottom platen to provide a flat surface for the molded polymer after processing. We also recommend that the wafer be left on the heated platen at all times to reduce the cycle time since it will not have to be reheated after each lamination. A 50µm thick PET sheet which is at least the diameter of the wafer being laminated should be placed on top of the bottom blank to protect the blank from the small amount of resist which will be extruded from around the edges of the TDFS during the process. Additional padding or protective layers may be used as desired. Further, these guidelines are generic in nature and will have to be adjusted to fit the specifics of the lamination tool being used.

1. Set both platens to the desired temperature and let them warm until a steady temperature is reached. We typically use the same temperature for both the top and bottom platens; although slightly different temperatures may be used depending on the thermal conductivity of the padding and protection layers. For simple laminations we recommend using a temp of 65°C to 75°C. Constant temperature should be maintained throughout the process.
2. Set the desired vacuum level to start the lamination process, the force level to be used for the process and the desired time under pressure if such controls exist.
3. Once the platens have reached the set temperatures the wafer to be laminated should be attached to the top platen and the SUEX™ TDFS set on the bottom platen and the two should be aligned so that the TDFS fits totally within the diameter of the wafer.
4. Close the vacuum chamber and allow the platens to warm back to the set temperature which should take only a few minutes.

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5. Once the set temperature has been reached start the vacuum pump and continue until the desired vacuum level has been reached. This may take from 1 to 5min depending on the capacity of the pump. The slower pump time allow better control of the vacuum overshoot. The vacuum line should have a shut off valve or bleed to prevent the vacuum from becoming excessive during the remainder of the process. The maximum vacuum for SUEX™ laminations in this temperature range should be no lower than 10mbar.
 6. Once the desired vacuum level has been reached (10-100mbar) start the piston drive for the press. It will take a few second until contact is made with the stack. Once reaching this point the pressure will start increasing quickly and will reach full pressure in 5-10sec. Once full pressure has been reached the pressure control should be turned off but the pressure maintained.
 7. Once full pressure has been reached the pump may be shut off as vacuum is no longer needed. The pump must be shut off before the lamination time is complete and the vacuum broken.
 8. The pressure is maintained for the desired time once full pressure has been reached. This is typically 30-60sec, but shorter or longer times may be used if so inclined. The trenches and cavities will be filled in less than this time but the longer the pressure is maintained the more uniform the thickness uniformity across the wafer will be.
 9. Once the desired set time has been reached the vacuum should be off and the nitrogen bleed valve should be opened. After 15-20 sec the exhaust valve may be opened and the chamber opened once atmospheric pressure has been reached. Do not turn off the platen heaters unless you are finished with your work.
 10. Once the chamber has opened the wafer is usually setting on the bottom platen on top of the SUEX™ sheet. Be careful though because the wafer and the SUEX™ sheet may remain attached to the top platen. Be ready to catch it if it falls. The laminated part along with the protective PET film should be removed from the bottom platen, turned upright and the protective PET removed. Note: there will still be the top PET coversheet on the laminated product. Leave this on until you are ready to continue. The protective PET should be inspected and replaced or cleaned if covered with extruded SUEX™.
 11. The laminator is now ready for the next lamination. If no additional wafers are to be process the laminator should be shut down.