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Owner's Manual

Apogee™ Bake Plate

Cost Effective Equipment

Contents

1. Apogee™ Bake Plate Introduction

1.1. Confidentiality Statement

Information supplied is for the use in the operation and/or maintenance of Cee equipment.
Neither this document nor the information it contains shall be disclosed to others for manufacturing or any other purpose without written authorization from, Cost Effective Equipment, LLC.

1.2. Warranty

Cost Effective Equipment, LLC warrants to the original purchaser (Buyer) that equipment is free from defects in material and workmanship under normal use and service in accordance with Cee instructions and specifications. Buyer Shall promptly notify Cee of any claim against this warranty, and any item to be returned to Cee shall be sent with transportation charges prepaid by Buyer, clearly marked with a Return Authorization (RMA) number obtained from Cee Customer Support. Cee's obligation under this warranty is limited to the repair or replacement, at Cee option, of any equipment, component or part which is determined by Cee to be defective in material or workmanship. This obligation shall expire one (1) year after the initial shipment of the equipment from Cee.
This warranty shall be void if:

(a) Any failure is due to the misuse, neglect, improper installation of, or accident to the equipment.
(b) Any major repairs or alterations are made to equipment by anyone other than a duly authorized representative of Cee. Representatives of Buyer will be authorized to make repairs to the equipment without voiding warranty, on completion of the Cee training program.
(c) Replacement parts are used other than those made or recommended by Cee.

CEE MAKES NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, WITH RESPECT TO EQUIPMENT. NO WARRANTY IS MADE AS TO THE MERCHANTABILITY OF THE EQUIPMENT NOR ITS FITNESS FOR ANY PARTICULAR PURPOSE. In no event shall Cee be liable for consequential loss or damages, however caused. No person or representative of Cee is authorized to assume for Cee any liability in connection with Equipment nor to make any change to this warranty unless such change or modification is put in writing and approved by an authorized representative of Cee in writing.

This warranty shall be governed by the laws of the state of Missouri U.S.A.

1.3. Returned Materials

Any materials, parts, or equipment returned Cost Effective Equipment, LLC must be clearly labeled with a Return Material Authorization (RMA) number.

To obtain a RMA number, contact:

Cee Customer Support
Telephone: (573) 466-4300
E-Mail: support@costeffectiveequipment.com
Web Address: http://www.costeffectiveequipment.com
Shipping information with RMA number:

Attn: Cee Customer Support
Cost Effective Equipment
3703 HyPoint Blvd
Rolla, Missouri 65401

1.4. Model and Revisions

The model and serial number information for the Cee® Apogee™ are located on the rear panel near the power inlet. Software version information can be found on the About screen. See DataStream™ Manual for screen shots and a detailed explanation of the system software.

1.5. Safety Hazards/Precautions

 Read this manual in its entirety before operating the machine.

1.6. Overview of Equipment-Specific Hazards

The unit is very heavy and proper precautions should be taken when handling the machine to minimize risk of injury. Labels are placed on the machine to identify areas where caution is needed during operation.

1.7. Electrical

 High voltage is present in the machine. Disconnect the power before servicing.

1.8. Mechanical

 This machine uses compressed gasses, which can provide motive force for components and can expand violently upon decompression. Disconnect N2 or CDA before removing any panels.

 Ensure that all panels are on and in their correct locations before powering up or operating.

 When opening the lid be aware of the pinch point at the hinge cover. Open the lid only by using the handle on the lid.

 The unit is very heavy and proper precautions should be taken when handling or moving the machine to minimize risk of injury.

1.9. Chemical

 Ensure chemical compatibility of all chemicals and materials being used inside the machine. This includes all wetted parts of the storage, supply, dispense, and waste systems.

 Ensure chemical compatibility of all chemicals with each other. All dispensed materials are held in one common waste storage tank. Check for reactions between chemicals before use.

 Flammable Chemicals. No open flames/sparks.

 Ensure proper ventilation/exhaust is used at all times.

 Always wear the proper Personal Protective Equipment for the job. This includes safety glasses, gloves and other equipment as needed to protect from mechanical and chemical hazards.

1.10. Lockout/Tagout Procedures and Information

Before servicing, turn off the machine and remove the power inlet cord by disconnecting the plug where it enters the machine.

1.11. Intended Use of Machine

The Cee® Apogee™ Bake Plate is intended for use as a Semiconductor/Optical. It is primarily intended for substrates up to the maximum size.

The Cee® Apogee™ Bake Plate is not intended for use in food or medical applications or for use in hazardous locations.

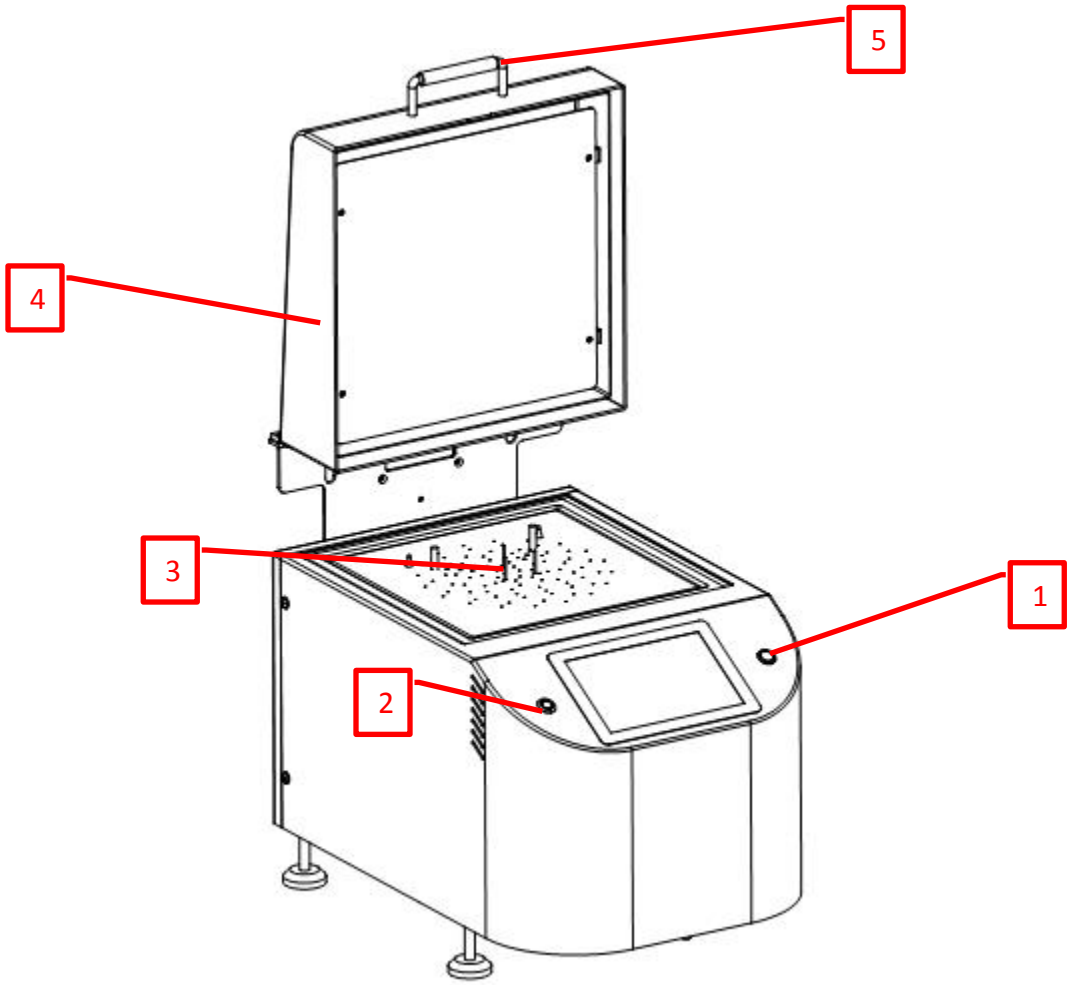
The Cee® Apogee™ Bake Plate is intended for use only by properly trained personnel wearing the proper personal protective equipment. Anyone not trained in the proper use and have not fully read this manual should not operate the equipment.

The Cee® Apogee™ Bake Plate is intended for use in a cleanroom environment to provide the proper processing conditions for the substrates. If it is used outside of a cleanroom environment, the substrate cleanliness may be compromised.

The Cee® Apogee™ Bake Plate is not intended for use in a hazardous or explosive environment.

2. Equipment Description

The Apogee™ precision bake plate features a revolutionary intuitive interface, a space-saving design, and track-quality thermal accuracy and uniformity. Fully programmable and user-friendly, the Apogee™ precision bake plate features the accuracy and repeatability needed to eliminate processing variability from critical experiments. Recipes are easily entered, monitored, and stored with the convenient full-color touch screen interface with DataStream™ Technology. Compact footprint, intuitive design, and unequaled experience add up to years of high-performance bake step processing, perfect for any low-volume or R&D laboratory processing environment.



1. **Power Button** – Used to turn on and off the tool
2. **User Presence Button** – Used for remote access (see DataStream™ Manual)
3. **Lift Pins** – Used to lift and lower the substrate
4. **Bake Plate Lid** – Cover for the bake plate working surface
5. **Lid Handle** – Used to open and close the lid

2.1. Dimensions

- 13-1/4" W x 19" D x 12" H (33.65cm W x 48.26cm D x 30.48cm H)
- Machine weight: 65 lb (29.48 kg)
- Shipping weight: 148 lb (67.13 kg)

2.2. Programmability

- Touch screen interface and display
- unlimited bake process programs
- Virtually unlimited steps per program
- 0.1-s resolution for step times with a range of
- 0 to 9,999.9 s/step
- Three automated bake methods: contact, vacuum, proximity
- Bake plate auto sizing for 2-in, 3-in, 100-mm, 125-mm, 150-mm, and 200-mm substrates
- Temperature data recording
- Password protection available at no charge
- Ramping capability optional (8 specific set points within single bake recipe)
- Electronic lift pins (replace N2 proximity for loading/unloading substrates from bake module). Program 10 specific proximity heights above the surface in any sequence or combination. Height is programmed in 0.001" increments with an overall range of 0.000" to 0.750"
- Energy-saving capability (for predetermined temperature output control)

2.3. Precision

- Substrate sizes: < 1 cm to 200 mm round; 8" x 8" square)
- Temperature resolution: 0.1° C
- Temperature range: ambient to 300°C (400°C optional)
- Temperature uniformity: ± 0.3% across working surface

2.4. Reliability

- Exceptional reliability and up-time
- 1-year full warranty parts and labor
- Free technical (live) phone support for the life of the product
- Application process assistance (live) for life of the product
- Exhaust bake hood design
- All stainless steel construction
- Exhausted hood for removal of process chemicals
- Optional nitrogen purge for inert bake environment

2.5. Utilities

- Voltage ranges: 100, 110-125, 208-240 VAC
- Power requirements: 1057, 1683, 1555 watts
- (16.7 amps)
- Exhaust port: 2" OD
- Vacuum: 20 to 25 in Hg
- Exhaust: 5 to 10 cfm
- N2 (for bake plate proximity): 35 psi

3. Installation

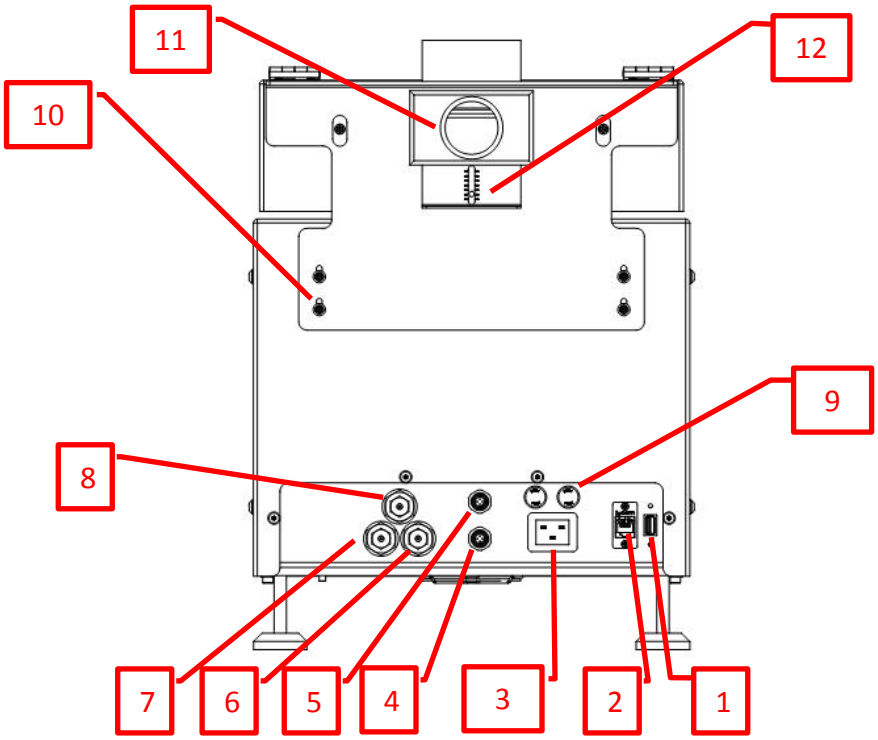
3.1. Floor Space Requirements

The Apogee™ Bake Plate is a bench top unit and requires a table or bench top for location. In most cases the supporting structure will be larger than the unit itself. The recommended freestanding space requirements are: 1'0" back to front and 0’3" side to side.

Dimensions: 13.25”L x 19”D x 12”H
Weight: 65 lbs

3.2. Facilities Requirements

The Apogee™ Bake Plate requires the following utilities for operation. Locations for connections are shown in the figure below.



1. **USB Port** – Used to update software or download log files (see DataStream™ Manual).
2. **Ethernet** – Can be used for remote recipe writing and remote control (see DataStream™ Manual).
3. **AC Power In** – Cord is Provided. Single Phase 100-120V AC at 10 Amps (208-240V A/C option available, see back label shown in Figure 1 to verify).
4. **Accessory Port** – This is used to talked to external I/O device to support extra outputs and inputs.
5. **Light Tree (Optional)** – Port for optional light tree.
6. **Vacuum Accessory Supply** –Can be used for items such as vacuum wands.
7. **System Vacuum** – System vacuum for the bake plate surface. Recommended vacuum Supply is 20 in Hg at a flow of 5 l/min. Port is ¼" barb fitting
8. **System N_2** – System nitrogen for proximity bake on the bake plate surface. Supply should be 35 psi.
9. **Fuses** – System protection fuses.
10. **Hood Height Adjustment**– 4 bolts can be used to adjust gap under the hood. An
11. **Exhaust Port** – Exhaust port for bake plate vapors. Port is 1 inch OD and 50 CFM of exhaust is recommended.
12. **Exhaust Gate** – Used to adjust flow rate of the exhaust on the bake plate by loosening bolt and sliding gate. Sliding up closes exhaust and sliding down opens exhaust.

3.3. Environment

The Apogee™ Bake Plate should be operated in a clean, low humidity environment.

3.4. Unpacking/Inspection

Thoroughly check machine for shipping damage. If physical damage is seen, **DO NOT APPLY POWER!** Contact Cee™ immediately.

The following items should be included with the shipment.

(1) Apogee™ Bake Plate
(2) Stop Pins
(1) Temperature and Humidity Sensor
(1) Power Cord with female power connector
(1) User & Installation Manual – CD or USB

3.5. System Installation and Setup

1. Lift the unit out of the packing crate by gra bottom only. **Do not** lift the by any of the top covers or protrusions. **Do not** roll or turn the unit on its side or ends.
2. Remove plastic wrap and packing foam.
3. Place Cee™ Apogee™ Bake Plate on a table of proper height and strength so that the controls and bake plate surface are at the proper ergonomic height.
4. Level the machine using the feet so that the bake plate surface is level front-to-back and side-to-side.
5. Thoroughly clean the bake plate surface.
6. Connect utilities to the reference diagram in Section 3.7.2
   (1) Connect the temperature/humidity sensor to the CAN terminal (#4).
   (2) Connect the vacuum supply to the vacuum fitting (#7)
   (3) Connect the nitrogen supply to the vacuum fitting (#8)
   (4) Connect the exhaust lines to the exhaust port (#11)
7. Plug in the machine.
8. Once plugged in, only the cooling fan should be powered, not the display.

3.6. Start Up

***For detailed software information, please refer to the DataStream™ manual**

1. Install the tool as shown earlier in Section 4.
2. Press the lighted power switch to turn the tool power on.
3. The display should momentarily show boot screen and then show main screen.
4. Enter the username and password.
    (1) The default username and password are “admin” and “admin2” respectively.
5. The tool will login and display the Process page.
6. Navigate to Tools- Manual Control to run system checks to ensure the tool is working properly.
    (1) Raise the lift pins down to 0 mm using the Set action.
    (2) Inset the supplied stop pins into the desired holes on the back plate surface. These stop pins keep the wafer centered on the bake plate surface. The holes closest to the center are for 2-inch wafers. From the center, the stop pin locations are for 2 in, 3in, 100mm, 125 mm, 150 mm, and 200 mm wafers respectfully.
    (3) Set Bake Method to Vacuum. Place a substrate onto the center of the bake plate and check that the vacuum holds the substrate.
    (4) Set the Bake Method to Proximity. This will turn off the vacuum and purge N_2 to float the substrate above the bake plate surface.
    (5) Set the Bake Method to Contact. This will shut off N_2 and the vacuum. Remove the substrate.
    (6) Ensure that the temperature/humidity sensor is reading on the parameter list.
    (7) Enable the Plate Temperature by selecting the Enable value and Apply.
    (8) Set the Plate Temperature to the desired temperature by changing the Action to Set.
    (9) Check that the Plate Temperature reaches the desire setting.
7. If the tool passes these checks, the tool is ready to operate. Begin by creating a recipe.

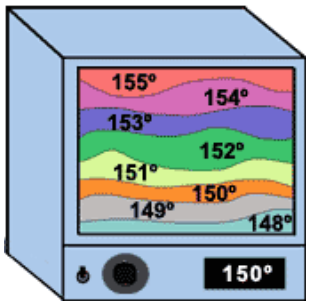
4. Bake Plate Theory

Hotplate bake processing has increased in popularity since the early 1980s. Previously the most common technique for film drying and curing was the convection oven. Bake plates (also known as hotplates) offer several advantages in the form of increased throughput, increased uniformity and reproducibility, and decreased particle contamination. In a typical bake process the substrate is placed into contact with a heated surface of known temperature. The substrate quickly rises to temperature. Drying and curing steps generally take about 1 minute. This is in contrast to traditional oven processes taking 30 minutes or more.

4.1. Bake Plates vs Conventional Ovens

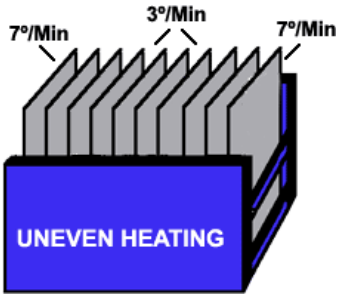
Bake plates have several advantages over convection type ovens:

- decreased bake time
- increased reproducibility
- better film quality.



This section will describe these differences and set a few guidelines for using bake plates.

Stratification, the formation of different temperature zones, is a problem associated with convection ovens and can severely affect film quality and reproducibility.



The heating rate of a substrate in an oven depends not only on the heated air flow past a substrate but also on its proximity to other cold substrates. Thus the heating rate for each substrate in a cassette of substrates that are being baked, will be less than if each substrate is baked alone.

In addition, substrates near the ends of a cassette heat faster than the substrates in the middle, thus producing a non-uniform heating

Particle generation also occurs within a standard oven. In a forced-air, convection oven, substrates are commonly exposed to a flow of particle laden air for at least 30 minutes.

During resin film cures, the substrates will be exposed to considerable particulate contamination. The substrates are vulnerable since the film may still contain solvents and during this ‘soft’ state, the film is very susceptible to having particles adhere to it.

4.2. The Skin Effect

Another disadvantage in normal oven baking results from baking substrates from the “outside in”. Since heat is applied to the outer surface of the film first, a skin forms on the surface of the film thus trapping solvents. Upon vaporizing, these solvents form blisters or bubbles which results in adhesion loss or even bulk film failure. This problem prevails in processes involving thick film resins, e.g. polyimides.

No skin effect occurs on a hotplate since hotplate baking heats the substrate from the bottom up. This “inside out” approach offers advantages for thick films since solvents in the film nearest the substrate are baked off before the film surface seals over.

4.3. Hotplate Bake Variables and Methods

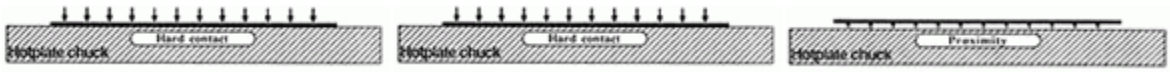
A typical bake process consists of preheating the surface to a known temperature, loading the substrate onto the surface for a specific length of time and removing it promptly at the end of the cycle. The selection of the temperature and time values used as well as the bake method employed all affect the overall performance of the process.

4.4. Bake Temperature

The bake temperature used is dependent on several factors. The material and substrate being baked as well as the results desired are key factors to be considered in developing a bake process.

In general, hotplate baking will be performed at temperatures slightly higher than those used in oven bake processes. The film being baked will reach a temperature somewhere between the temperature of the hotplate and the ambient air above the film. As an example, with a hotplate surface temperature of 115°C, a layer of photoresist on a silicon wafer will reach a final temperature of about 105°C after a few seconds. Thicker substrates and/or substrates with lower coefficients of thermal conductivity will require even higher temperatures to compensate for this phenomenon.

4.5. Bake Methods



Another important factor is the method of bake. Cee® hotplates allow for three distinct bake methods; proximity, soft contact, and hard contact.

In a hard contact bake the substrate is held onto the hotplate surface by the application of vacuum to the underside of the substrate. Small holes are machined into the hotplate surface in a pattern which optimizes vacuum distribution without the formation of cold spots or warping of the substrate. This method is usually preferred for silicon and other flat substrates where back side contact is not a problem.

Soft contact baking uses gravity alone to hold the substrate onto the hotplate. This method generally offers less uniformity since the substrate-hotplate thermal interface is not as efficient.

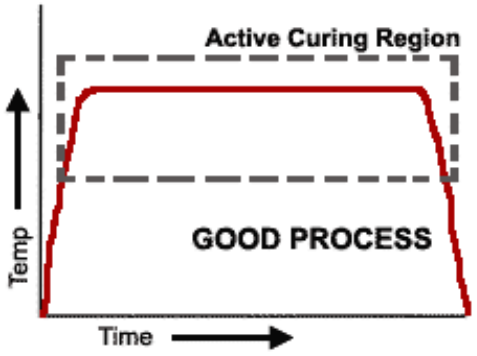
Proximity baking is accomplished by forcing nitrogen through ports in the hotplate surface. This forces the substrate to float at a distance of one to four mils (25-100μm) above the hotplate surface. Proximity baking allows a slower warm-up than contact bake methods and can be advantageous when baking thick films where blistering would otherwise be a problem.

Another advantage of proximity baking in this manner is that in many cases cambered or warped substrates can be baked with a high degree of uniformity. This is usually not possible with the contact methods since it is not possible to achieve a vacuum under a substrate that is not flat to start with. Processing cambered substrates with the soft contact method creates hot spots where the substrate touches the hotplate and cold spots where it does not. It should be noted as well that this type of proximity process is “self-leveling” in that the substrate will tend to form a uniform gap to the hotplate surface.

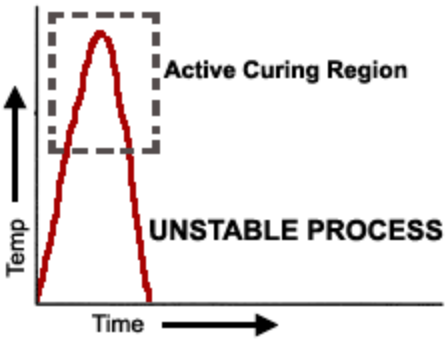
Proximity baking also offers the unique advantage of allowing hotplate processing without touching the bottom side of the substrate. An example of this application is photomask processing. In processing these relatively thick glass plates it is important that the back side of the glass not directly touch the hotplate since this causes micro-fractures in the glass itself from rapid heating. By performing the entire bake process in the proximity mode the integrity of the substrate is not endangered and the uniformity is excellent.

4.6. Bake Time

The selection of the bake time parameter plays an important role in the reproducibility of the bake process. Substrate thermal properties and the choice of bake method greatly affect the amount of time necessary for the substrate and therefore film temperature to stabilize during the bake. Thicker substrates and the use of proximity bake methods will increase the time necessary for the film to reach its final temperature. It is important that most of the baking action in the film takes place after this temperature is reached. A silicon wafer will reach a stable temperature within a few seconds and so it is traditional to adjust a photoresist bake processes to be completed in 60-90 seconds with an appropriate bake temperature.



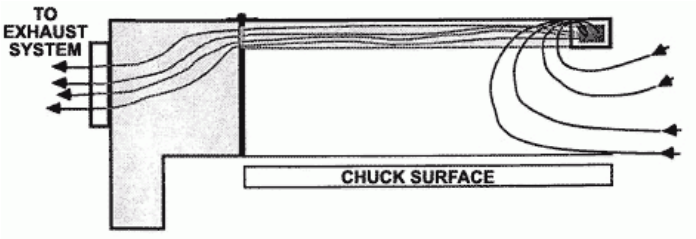
For thicker substrates such as photomasks and ceramic modules the increased time necessary to heat the larger mass of the substrate results in bakes times approaching five minutes. It should be noted that these substrates can be processed with higher temperature and much shorter bake times but reproducibility may suffer. If the bake time is too short then a significant amount of the actual bake process will take place during the loading and unloading steps as well as while the substrate is cooling after removal from the bake plate. This is an unstable condition since it is very difficult to exactly reproduce conditions during these steps.



In general the temperature-time relationship in a bake process can be taken as a "dose" of the (temperature) x (time) product. Increasing the bake temperature results in a need for decreasing bake time. The limits for both parameters can be reached when the process is no longer reproducible or when the physical temperature limitations of the resin or substrate have been reached.

4.7. Exhaust Cover

The design of the Cee®exhaust cover promotes the dissipation of vapors removed from a substrate placed on the chuck, without drawing air across the chuck surface.



4.8. Oven vs. Bake Plate Examples

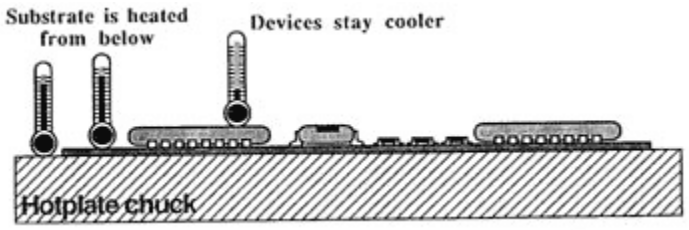
The chart below presents process examples for a commonly used resins. These figures should not be use as a rigid guideline, since the best method with a particular baking application can only be achieved through experimentation.

- **APPLICATION:** Positive Photo Resist
- **OVEN BAKE**
  - 90°C – 30 minutes, Polyimide beta (partial imidization)
  - 135°C – 30 minutes, Polyimide alpha (solvent removal)

- **HOTPLATE BAKE**
  - 115°C – 30 secs w/Hard Contact bake, Polyimide beta (partial imidization)
  - 150°C – 15 secs w/Proximity bake, 150Â°C – 90 secs w/Hard Contact bake, Polyimide alpha (solvent removal)

4.9. Reflow Soldering

Bake plate processing heats the substrate and the solder without applying heat directly to the devices on the board. Using a combination of proximity and hard-contact bakes, the bake profile can be adjusted to suit any process.



4.10. Bake Plate Process Troubleshooting

As with the spin coating process there are no absolute rules for bake plate processing, only general guidelines. Following is a list of issues to consider for specific bate plate process problems.

Film overbaked	
Bake temperature too high	Select lower temperature
Bake time too long	Decrease bake time
Film underbaked	
Bake temperature too low	Select higher temperature
Bake time too short	Increase bake time
Film blistering or cracking	
Unstable balance in temp. / time parameters	Decrease temp. / increase time
Warm-up time too fast	Use proximity bake to preheat substrate
Non-uniform bake	
Unstable balance in temp. / time parameters	Decrease temp. / increase time
Operating with exhaust lid raised	Lower the exhaust lid
Unstable ambient conditions	Protect against major fluctuations
Bake time too short	Increase bake time
Bake plate surface contaminated	Clean surface of bake plate

5. Bake Plate Options

5.1. 400°C Option

The 400°C option allows the user to set the max hat chuck value to 400°C. If the tool is being operated above 300°C, please see the instructions below. Serious tool damage can occur if the following is not setup as instructed.

1. The four leveling must be adjusted to allow a 2 inch gap between the table top and the bottom of the tool.
2. The equipment MUST be connected to at least 10 CFM and the exhaust gate on the bake plate must be fully open.

6. Preventative Maintenance

This maintenance manual provides personnel with procedure and guidelines for maintaining a Cee® Apogee™ Bake Plate. Below is a chart of recommend maintenance scheduling.

Maintenance Section	Maintenance Schedule
Safety Checks	Before daily tool use
Cleaning	After daily tool use
Mechanical Checklist	See Section 5.2 for Details
Utility Checks	See Section 5.3 for Details

6.1. Safety Checks

Inspect bake plate lid for the following defects:

(a) Loose assemblies
(b) Improper closure
(c) Improper exhaust connection

6.2. Mechanical Checklist

1. **Bake plate surface:** If any material has built up on the bake plate, it can be wiped clean with most organic solvents isopropyl alcohol, or acetone. For major buildup of material a glass microscope slide can be used to gently scrap the material away. Hold the slide at a 45° angle so you do not scratch the surface. Follow by wiping clean. A dirty bake plate could cause vacuum errors. **Weekly**
2. **Lift pin planarity:** If the three lift pins are lifting the wafer at an angle relative to the bake plate surface, the pins can be adjusted to compensate. **Quarterly**
3. **Lift Pin Height:** If the three lift pins are not lifting the wafer the programmed amount of distance from the bake plate surface, they may require calibration. **Quarterly**

6.3. Utility Checks

1. Check all pressures for ranges specified in tool manual. **Daily**
2. Verify that the exhaust is functioning. **Daily**
3. Inspect all connections for proper installation. **Bi-Annually**
4. Verify that the AC power is of the proper voltage, and is connected. **Bi-Annually**

6.4. Cleaning

For cleaning, it is good practice to use the mildest solvent possible. The machine cabinet may be cleaned using most organic solvents, acetone, isopropyl alcohol, or N-methylpyrrolidinone (NMP). Caustic acids or bases should not be used. The bake plate lid may be cleaned with isopropyl alcohol, acetone, or water based cleaners.

Avoid getting solvent of any kind on the small yellow "Hot Surface" labels. Use only water-based cleaner on the labels on the rear of the machine. Use only isopropyl or water based cleaner on the "power on-off", Cee® logo, the yellow "Caution ... Eye Protection", and the "Cee® model/serial number" labels. The display may be cleaned with glass cleaner, water, or isopropyl alcohol.