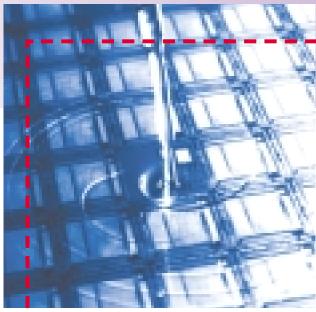



*One of a Series of Technical Reference Publications*

# Spin / Bake / Cure Procedure for Spin-On-Glass Materials

## For Interlevel and Intermetal Dielectric Planarization

## APPLICATION SCOPE

Effective utilization of Honeywell spin-on glass materials for the planarization of integrated circuits requires that the proper spin/bake/cure procedures be applied in order to achieve a high quality film. Application Note Number 1 describes the correct processing to be followed along with some general guidelines on how to select the appropriate application equipment.

Honeywell's Accuglass® spin-on glass (SOG) materials differ significantly from other spin-on materials used in IC fabrication technology such as photoresist or polyimide. Compared to a typical photoresist, these solutions usually have much lower viscosities (1 to 3 cP), more volatile solvents and are sometimes acidic. When the solvent(s) (primarily alcohols and ketones) evaporate(s) during the spin-coat process, an insoluble residue (usually a fine silicate dust) is produced. This residue can be a major source of particles on the wafer surface. These particles can be eliminated or greatly reduced with the use of a properly designed spin-on glass coater.

## EQUIPMENT SELECTION

In order to reduce particulate and other problems associated with SOG deposition, it is important to choose spin-coating equipment specifically designed for SOG. SOG coaters are commercially available from multiple sources. It has been found that certain features are important for producing excellent quality SOG film:

### 1. Constant and Measurable Cup Exhaust.

It is recommended that the exhaust be on during all process steps. The exhaust must be high enough to evacuate the solvent vapor and to keep the mist, formed during the spin, below the plane of the wafer surface. The recommended exhaust flow is 20mm-40mm H2O (25mm is typical). Different coaters may use different units to measure exhaust (i.e., mm Hg, or liters-per-minute). Regardless of the units on the gauge, a gauge is required to show relative exhaust changes. The exhaust must be kept constant to ensure process control and repeatability, because the exhaust impacts the spin cup ambient temperature, which in turn affects film thickness. A warmer system can cause an increase in film thickness.

### 2. Cabinet Exhaust.

The cabinet exhaust must be high enough to properly exhaust both the cabinet and the SOG delivery system. The cabinet exhaust must be high enough so that as the machine warms up, both the cabinet and the cup stay at the same temperature.

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## EQUIPMENT SELECTION, CONTINUED

### 3. Programmable Spinner Cup Solvent Rinse Capabilities.

Spinner cup rinse is required to prevent SOG from drying on the inside of the cup and becoming a source for particles. Cups should be made of PVC or POLY because these materials wet well with cup-rinse solvents; good wetting ensures complete rinsing of the residual SOG, which lowers particle levels.

### 4. Adjustable Solvent Nozzle Capabilities.

The solvent nozzle tip should be adjustable for distance (vertical and horizontal) and direction/angle of dispense. An effective solvent rinse helps prevent particle formation.

### 5. SOG Handling System.

Recommended materials for the SOG delivery system are Teflon, PTFE, PFA or polypropylene, which are compatible with highly polar organic solvents such as alcohols, ketones and esters. Delivery system components include cap adapters, system lines, O-rings, and the SOG bottles. The spinner cup and pressure bottle cap adapter need to be compatible with HF which is used to remove residues and particles.

*NOTE: Metal components should not directly contact the SOG.*

### 6. Pressurized Dispense.

Pressurized dispense for SOG using helium instead of nitrogen is recommended. The helium molecule is less soluble in the SOG when under pressure. Therefore, it desorbs less, forming fewer bubbles than nitrogen during dispense and spin. Optimum control over dispense is achieved by using a precision 0-5 PSI regulator. Pressure canisters are not recommended.

*NOTE: Some manufacturers use nitrogen for this application with good results.*

### 7. Cap Adapter.

The use of a special SOG cap adapter, available from Honeywell, (see figure 1) is recommended. The adapter allows pressurized helium dispense directly from the SOG bottle, therefore reducing the probability of solution evaporation, contamination, and particle formation.

*NOTE: A pressure certified vessel to contain the SOG bottle may be required to meet local regulations).*

### 8. Chuck Material.

The chuck should be constructed from polypropylene, Delrin, P.E.E.K., or Kel-F and designed so that the memory of the chuck leaves no imprint on the wafer after the SOG deposition.

*NOTE: If thicker SOG is observed in the center of the wafer, the chuck may be too small relative to the wafer or not optimally designed.*

### 9. Spin Ambient.

The recommended temperature and humidity for spin coating SOG is 70°±2° F, and, 35±3% relative humidity in the spin cup. Optimally the fab area for the spinner should also be controlled to these conditions. If the fab area cannot be well controlled, commercially available (i.e., SEMIFAB) temperature and humidity control chambers over the spinner cup have been shown to work successfully.

### 10. Edge Bead Removal.

Ideal edge bead removal (EBR) capabilities should include both backside rinse and topside EBR features. Topside EBR may be necessary in process flows that incorporate post SOG processes where mechanical systems clamp both the front and backside of the wafer edge. Thick SOG on the edge is a potential source of particles when clamped. Many SOG users have good results with the backside rinse only. The traditional EBR rinse solvent is isopropyl alcohol(IPA). Many siloxane users are experiencing superior performance from other solvents such as ethyl lactate. Please contact Honeywell for more information.

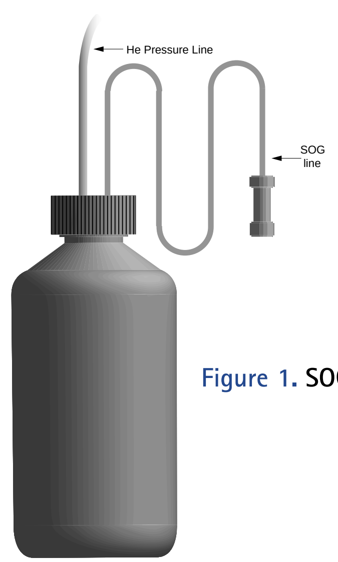



**Figure 1. SOG Cap Adapter**

# SPIN

## Typical Recipes For 100mm, 125mm, 150mm, 200mm Wafers

### Dynamic Dispense (Single or Multiple Coats)

| | Step #1 Dispense | Step #2 Delay time | Step #3 Dry | Step #4 Reduce Speed | Step #5 EBR (If EBR equipped) | Step #6 Dry |
|---|---|---|---|---|---|---|
| Spin | 150RPM | 150RPM | 3000RPM | 1500RPM | 1500RPM | 3000RPM |
| Time | ~3 Secs.* | 0.2 Secs. | 10 Secs. | 2.0 Secs. | 6.0 Secs. | 8.0 Secs. |
| Exhaust | Exhaust On | Exhaust On | Exhaust On | Exhaust On | Exhaust On<br>Solvent On | Exhaust On |

**Dispense time will depend on SOG flow rate.*

### Spin Stop For Improved Planarization

| | Step #1 Dispense | Step #2 Delay time | Step #3 Dry | Step #4 Stabilize Speed | Step #5 EBR (if EBR equipped) | Step #6 Dry |
|---|---|---|---|---|---|---|
| Spin | 150 RPM | 3000RPM | 3000RPM | 1500RPM | 1500RPM | 3000RPM |
| Time | ~3 Secs.* | 20.0 Secs. | 20 Secs. | 2.0 Secs. | 6.0 Secs. | 8.0 Secs. |
| Exhaust | Exhaust On | Exhaust On | Exhaust On | Exhaust On | Exhaust On<br>Solvent On | Exhaust On |

**Dispense time will depend on SOG flow rate.*

*NOTE: Maximum spin acceleration is always best for spin cycles.*

*Notes: Dynamic dispense is shown to produce better films (uniformity and planarization) on patterned 125mm or larger diameter wafers. Static dispense can often produce higher quality films on smaller wafers such as test wafers. This must be tested in the individual case.*

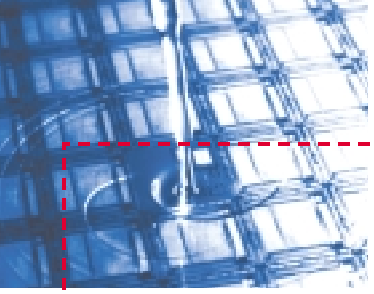
*A hot plate bake sequence follows each dispense sequence. For subsequent coats the dispense/bake sequence is repeated. Before depositing the second coat, the wafers must be cooled to room temperature. This can take from 10 to 30 minutes depending on wafer size and thickness. A dry atmosphere (less than or equal to 40% humidity) is recommended during the cooling. This is especially critical for phosphosilicate SOG material due to the hygroscopic nature of phosphorus doped glasses.*

### Refrigerated Storage

SOGs require refrigerated storage. This ensures the optimum shelf life as specified on each bottle. Recommended storage temperature is -2°C to +4°C.

### Warm Up Time for Bottles

Before installing a fresh SOG bottle on the spin coater, the bottle should be allowed to equilibrate at room/fab temperature for 24 hours. Cold SOG can give poor quality films and higher particle levels. When space is available, it is ideal to allow bottle warm-up inside the spin coater cabinet as long as there is no contact between the cold and warm bottles. Bottle warm-up inside the spin coater also allows the new material to be connected with minimal agitation.





## SPIN, CONTINUED

### Step 1 Dispense:

For dynamic dispense (Wafer rotating prior to dispense), the spin speeds can be varied between 150 RPM and 360 RPM. The spin speed is adjusted to give the optimum uniformity for a particular spin coater/SOG combination. A dynamic dispense that is too slow will give a thicker film in the center of the wafer. A dynamic dispense speed that is too high will cause thinner SOG film in the center of the wafer, and inferior planarization. A standard recommended cup exhaust setting is 25mm $H_2O$, but can be adjusted between 20mm to 40mm $H_2O$, in order to produce film with the best uniformity and fewest spin defects. (See spin defect maps on page 7.)

The recommended dispense volume is achieved by varying dispense time. First, a flow rate is empirically determined. Then, the dispense time is calculated. Dispense time is determined by a flow rate check; for example a typical flow rate for 1/8" ID. Dispense line is about 1.2cc per second (5 psi will produce this flow). Dispensing 3.0cc on 6" wafers therefore usually takes about 2.5 seconds (1.2 x 2.5 = 3.0).

**Recommended Dispense Line Diameter (Inner)**

**100mm / 4" Wafers = 1/8"**
**125mm / 5" Wafers = 1/8"**
**150mm / 6" Wafers = 2 x 3mm**
**200mm / 8" Wafers = 3 x 4mm**

The diameter of the SOG dispense line should be selected so that the correct volume (relative to wafer size) of SOG can be dispensed in 2 to 3 seconds at 5 psi helium. If less than 5 psi helium is used, the high SOG velocity creates a danger of splash, and a longer dispense time may cause the SOG to be thicker in the wafer center due to solvent evaporation. The optimum dispense line length is the shortest possible distance between the SOG bottle and the dispense tip that still allows for easy bottle change. A short line takes less SOG to fill after flush, and is therefore more cost effective. Long lines are more likely to become sources of particulates. Most coaters are initially supplied with Teflon lines, but when line replacement is required, polyethylene may be substituted to reduce cost.

*NOTE: If too much SOG is dispensed, "splash back" might occur. This will be visible as drops of SOG on the front or back of the wafer. Backside drops can be removed by a backside rinse. Uniformity can also be affected, and thick areas may be observed. If too little SOG is dispensed, wedge shaped areas of uncoated wafer surface pointing towards the center of the wafer, along with particles, will be observed (see wagon wheel spin defect map/pattern, page 7).*

### Step 2 Delay Time (Dynamic Dispense Only):

This step can improve film quality with minor adjustments. Optimum delay time is usually set between 0.1 and 0.3 seconds. The short delay between dispense and high RPM spin out has shown to produce better planarization and better wafer to wafer uniformity.

### Step 3 Spin (Out) Time:

After maximum acceleration to 3000 RPM, spin time is typically 6 to 10 seconds for optimum planarization. Using a spin stop program (1 -2 seconds at 3000 RPM followed by a stop for 18 seconds) has also shown excellent planarization for some topographies. Longer (i.e., 20 seconds) high RPM spins can reduce planarization, decrease uniformity, and increase SOG edge bead. However, the optimum spin out recipe must be determined for each topography and wafer diameter.

### Steps 4, 5 & 6 Backside Edge Bead Removal Sequence:

The basic spin speed for EBR is 1500 RPM. The RPM can be adjusted to control the amount of SOG removed (optimum RPM will depend on wafer diameter). A slower RPM allows the backside rinse to migrate and wrap around the edge of the wafer, therefore removing more of the SOG edge bead.

# BAKE

The SOG process usually includes a triple hot plate bake sequence after each spin coat. The most effective hot plate bake configuration starts with a low temperature hot plate and increases with successive plates.

These sequential temperature increases allow gradual solvent evaporation. A low initial hot plate temperature can improve planarization and lower film defects. When multiple coats are utilized, the temperature of the hottest plate should sufficiently crosslink the film so that it is not dissolved by the solvent of subsequent dispenses. Recommended bake time is 40-60 seconds. Longer bake times can cause adhesion problems when multiple SOG coats are deposited.

### Typical Hot Plate Bake Sequence

| Hot Plate #1 | Hot Plate #2 | Hot Plate #3 |
|---|---|---|
| 80°C | 150°C | 250°C |
| 60 Secs. | 60 Secs. | 60 Secs. |

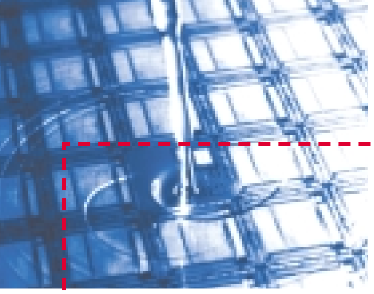
# CURE

The standard cure recommended for SOG is 425°C for 1 hour in nitrogen for all size wafers although some users cure at 400°C. For curing SOG films at temperatures below 425°C, it is advised that the wafer or substrate not be subjected to subsequent process step temperatures greater than 50°C above the cure temperature. Higher cure temperatures can result in film outgassing, and/or shrinking/densification that can result in cracking. Curing above 450°C can change siloxane film composition, as siloxanes begin to lose the methyl groups that help to relieve film stress and prevent cracking. At higher temperature cures (450°C - 475°C) silicate and phosphosilicate films become denser without any change in film composition. When curing thicker SOG films (i.e., 2 coats of 311—6200 Å), it is recommended that the wafers start in a furnace at 300°C and ramp up to 425°C at a rate of 2.5°C per minute. Temperature should remain at 425°C for 1 hour and then ramp down at a rate of 5.0°C per minute. A ramped cure reduces stress in the film.

When cures over 450°C or shorter than 1 hour are desired, Honeywell should be consulted for process recommendations for both silicates and siloxanes. Curing is usually performed in a basic diffusion furnace specifically designated for this purpose (maintained at 425°C). A high nitrogen flow is recommended to help prevent the possibility of cracking the SOG. A typical flow for 8-inch wafers is 20 liters/minute. Some spin coater manufacturers are offering a cluster-curing feature that includes a furnace. Robotic handling loads SOG coated and baked wafers directly into the furnace for cure immediately following SOG deposition. This eliminates a handling step and delay time (queue time) between last bake and cure. It also easily allows full cures between SOG coats.

## Queue Time

A minimum of time should elapse between SOG spin/bake/cure steps. Most SOG users "specify" that no longer than two hours pass after SOG deposition, bake and final cure. As with most fab processing, it is recommended that wafers be stored in a dry atmosphere (humidity <40%), drybox, or nitrogen purged cabinet between steps. If a longer wait time is unavoidable, wafers can be re-baked using the standard bake recipe (without the dispense step) used when spin coating. This re-bake will drive off any moisture that the wafers may have absorbed while idle. Wafers should be allowed to cool before the next process sequence. The use of a chill plate is not recommended as it may result in cracking. If a chill plate must be used, it should be at room temperature.





# TROUBLE SHOOTING

The most common problems that occur in the spin coat deposition of SOG are particulates, poor uniformity, and spin defects, hazing, and cracking. Possible causes and solutions are listed below:

| PROBLEM / CAUSES | SOLUTION |
|---|---|
| **1. PARTICULATES** | |
| */SOG too cold* | Let the SOG bottle warm up for 24 hours before use. Cold SOG can add 50 or more particles to optical (water surface) defect counts. |
| */Cup not clean* | Establish a cleaning schedule where the cup is cleaned regularly with IPA. Assure that the cup rinse is working and/or increase the cup rinse flow. An effective cup rinse also makes cup maintenance easier. If the cup becomes contaminated with dried SOG, an HF rinse may be necessary to remove particles. |
| */No cup rinse* | IPA rinse keeps the cup wet and prevents SOG spun off the wafer from drying on cup walls and becoming a potential particle source. An efficient and well maintained cup rinse is highly recommended. |
| */Exhaust too low* | Causes high particle and defect counts (up to 300 on test wafers). Exhaust should be increased; the setting will vary depending on the particular spin coater and the configuration. (see recommendations) |
| */Suck back too far* | Air gets into the dispense tip and dries SOG that becomes a particle source. Repair suck back or adjust to function correctly. |
| */Unclean dispense line* | SOG bottle to dispense tip line not effectively flushed or SOG allowed to dry in line. Large numbers of particles will be counted on test wafers. This often will be found after a weekend or longer period of spin coater dormancy. A repeated series of IPA flushes (12 or more) can sometimes solve the problem. If this does not work, the line must be replaced. |
| */Unclean dispense tip! nozzle* | Dried SOG on a dispense tip can become a source of particles. The tip should be cleaned with IPA and flushed (along with the dispense line) on a regular basis, or when particle problems occur. Dried SOG may require HF for removal. |
| */IPA flush solvent contains particles* | After flushing a dispense line with IPA, go through the spin-coat cycle depositing IPA instead of SOG on a test wafer. Do an optical particle count on this test wafer. If the particle count is high, dump the IPA, replace the flush bottle with a new bottle filled with fresh IPA, flush the system and repeat the particle count on another wafer. |
| */Point-of-use SOG filtration* | The use of an SOG filter between bottle and dispense nozzle should be considered. Filter may help to dissolve gas bubbles, as well as filter-out any small particles which might occur. |
| */SOG bottle to dispense tip line is too long* | The optimum dispense line length is the shortest distance between the SOG bottle and the dispense tip (that will allow easy bottle change). Long lines are more likely to be sources of particulates. |
| */Unclean test wafers* | Test wafers not fully clean before optical particle count (occurs primarily when test wafers are stripped and reused too many times). Allow test wafers to be stripped for a longer period of time or post strip spin-rinse-dry thoroughly. However, virgin wafers are recommended for particle tests. |
| */Inefficient cup rinse* | Insoluble SOG deposits formed by evaporation of SOG on the various spinner surfaces may flake off and result in particulate defects in the films. The cup rinse feature should be checked for proper operability. The cup rinse IPA flow may need to be increased for optimum rinse efficiency. |
| */SOG bottle left in the spin coater too long* | The SOG bottle should not be left in an idle system for longer than 5 hours because it could become a source of particles. If only a small number of wafers are run at any onetime, a smaller bottle size (smallest = 125ml) is recommended. This guarantees a fresh SOG bottle for each new set of wafers. If a large number of wafers are being run, a larger bottle will prevent a loss of time during frequent bottle changes. Optimum bottle size depends on throughput. |

Teflon does not wet well and unrinsed, dried SOG can become a source of particles. PVC and POLY wet well, and have proven to be more suitable cup materials.

*/Inappropriate cup material*

*NOTE: For general particle qualification, start with an IPA dispense and particle count, so the system is known to be clean. When the system is clean, the SOG film test run particle count can be made. (See Trouble Shooting for Particles Flow Chart).*

## 2. SPIN DEFECTS (particles in patterns)

Spin defects and particles are often both counted as particles when optical based metrology systems are used. The major difference between the two is that spin defects do not contain a particle or particulate matter. Spin defects will not show up with even distribution, but will occur in definite patterns (i.e., donut shaped particle ring with a particle free center zone, wagon wheel like spokes emanating from the center of the wafer along the radii).

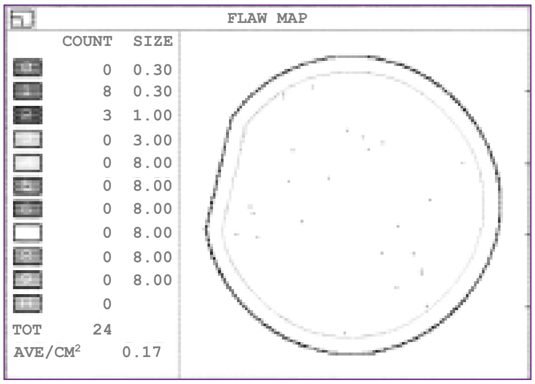



**Figure 2.** 300-RPM Dynamic dispense (3 seconds). 3000 RPM (12 seconds). 6 inch wafer. Pre Coat Particle Count — 25 (Particles 0.2pm). Total Particle Count —36. Actual Particles Added — 11.

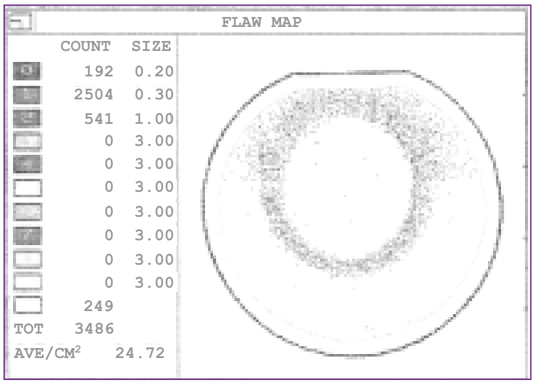



**Figure 3.** Donut Spin Defect

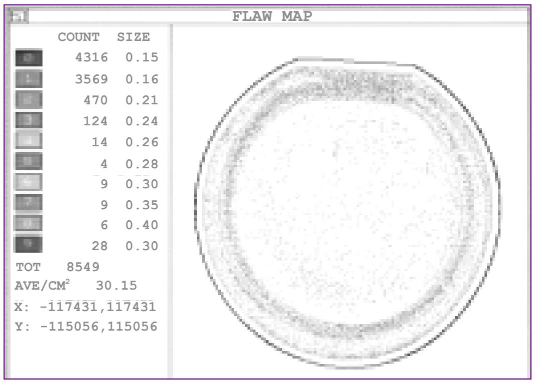



**Figure 4.** Low Dispense Volume Spin Defect

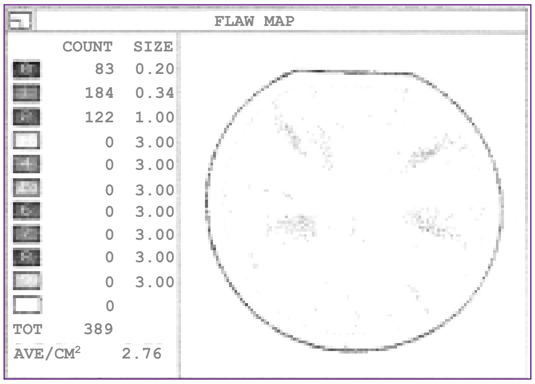


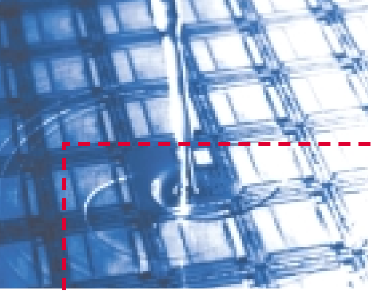

**Figure 5.** Wagon Wheel Spin Defect

This can cause spin defects as solvents evaporate too rapidly. A lower first hot plate temperature will allow a more gradual bake. See the bake recommendations which can be used as a guideline.

*/Initial hot plate temperature too high*

On larger wafers dynamic dispense is recommended. SOG that sits on a static wafer during the longer dispense time that is sometimes required to effectively coat a larger wafer may cause spin defects.

*/Static dispense on wafers greater than 4' in diameter*





# TROUBLE SHOOTING

| PROBLEM / CAUSES | SOLUTION |
|---|---|
| **2. SPIN DEFECTS, continued** | |
| */Incorrect diameter of SOG dispense line* | There is an optimum dispense time and flow rate for SOG. Larger wafers require a greater flow rate of SOG to be deposited in the same dispense time, at the same pressure and velocity. This requirement dictates a larger dispense line. Dispense line recommendations should be used as a guideline. |
| */Inappropriate chuck material* | The spin chuck should be made of Kalrez or polypropylene. These materials are easily kept clean and are compatible with silicon and SOG. Metal chucks chill the wafer and cause spin defects and poor uniformity. Teflon chucks are too soft and, at high RPM, distortion occurs creating abnormal coating patterns |
| */Insufficient cup exhaust* | The SOG solution tends to form a mist of liquid droplets above the substrate during the spin. This mist may produce particles or bubble-like defects in the films. Increasing the cup exhaust flow will often cure this problem. |
| **3. HAZE** | |
| */SOG too cold* | Allow the SOG bottle to warm up for 24 hours before use. Haze from cold SOG is due to moisture condensation onto the film during spin. |
| */High humidity* | It is recommended that the humidity in the spin cup be controlled between 37% and 43% for best results. Phosphosilicates (especially those with 4% or greater mole percent, P205) require a lower humidity due to the hygroscopic nature of phosphorus doped glass. 25% to 35% humidity is recommended for phosphosilicates. High humidity will cause haze related to condensation. |
| */Low cup or room temperature* | Increase the cup temperature to at least 68-72°F. Temperature and humidity control chambers that enclose the entire cup assembly are available. |
| **4. POOR THICKNESS UNIFORMITY** | |
| *Thicker Film in the Centers* | |
| */Too much time between dispense and spin out* | Decrease the amount of time between dispense and spin out. |
| */Dispense line too small* | A problem on larger diameter wafers. The SOG dispense takes too long. Follow recommendations for wafer diameter/tubing size. |
| */Wafers still warm from first SOG spin-coat-bake* | Allow more time for cooling after the initial SOG coat and bake sequence. |
| */Pre SOG deposition baking /"Pre-bakes"* | Pre-bakes are not recommended. If the wafer is still warm when the next layer of SOG is deposited, a lack of thickness uniformity may occur. |
| *Thinner Film in the Centers* | |
| */IPA dispense nozzle rinse drips IPA during dispense* | Adjust the IPA nozzle rinse feature so that no IPA drops escape during SOG dispense |
| */IPA is still in the dispense line after the flush* | More SOG should be run through the line before wafers are coated. |
| */Insufficient first coat bake* | On wafers that will receive a double coat of SOG, bake the first coat at a sufficiently high temperature (cure) to prevent dissolution of the first coat. |
| */Spinner warm-up* | The hot plates must be given enough time to reach the equilibrium temperature. Insufficient bakes are a problem when double coats are applied (see above). |

| | |
|---|---|
| | *Poor Uniformity (General)* |
| Allow the SOG bottle to warm up for 24 hours prior to use. | */SOG too cold* |
| Using the recommended range for exhaust settings, coat patternless wafers (of the same diameter as the production wafers) by varying the setting until the optimum uniformity is achieved. | */Exhaust out of adjustment, either too high or too low* |

## 5. FILM CRACKING

| | |
|---|---|
| It is critical that deposited SOG films enter and leave high temperature cure furnaces slowly. This prevents cracking that can occur when materials with different thermal expansion coefficients in contact with each other make rapid thermal changes. | */Rapid furnace push or pull time* |
| A ramped cure beginning at 300°C is recommended. (See "cure" section.) | */Thick SOG (i.e., 2 coats of 311)* |
| SOG spun on at a much lower RPM than recommended or multiple coats of an SOG can produce a film above the recommended thickness and will tend to crack during cure. This tendency increases as wafer surface topography becomes more severe. Often when a thicker film is desired, an alternate SOG can be found to fulfill the need. | */SOG thicker than intended* |
| After the hottest bake, cooling wafers may be placed on chill plates which are not in operation or are set at room temperature. A true cool plate that is set to be "cold" can cool the wafer too quickly causing stress and cracking. | */Chill plate* |

## 6. INCOMPLETE COAT

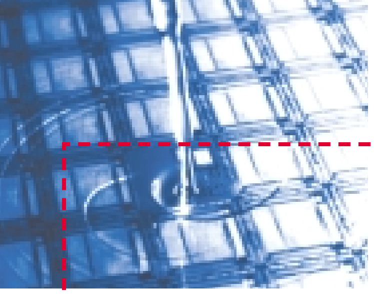
| | |
|---|---|
| Increase dispense volume. Low dispense volume may also cause spin defects and poor planarization. | */Low dispense volume* |

## 7. PUDDLING, PULLBACK AND POOR ADHESION

| | |
|---|---|
| If subsequent SOG coats do not adhere well, reduce the bake time to between 40 and 60 seconds per bake plate. | */Bake too long* |
| Time between the first and second SOG depositions should be no greater than 2 hours. The film may absorb moisture during longer waits. If longer queue times are unavoidable, the wafers should be held in a "dry" box. | */Queue time too long* |
| SOG must be fully cooled before the next coat is deposited. (wafer surface too hot.) | */SOG Film (Wafer) too hot* |

## 8. POOR PLANARIZATION

| | |
|---|---|
| When a thicker film is required (usually determined by SEM examination), two approaches can be taken: (1) Deposit a multiple (usually double) coat of SOG , or (2) Use a thicker SOG of the same product family. | */SOG too thin* |
| Lower first bake plate temperatures (recommended temperature is 80°C) allow solvents to leave the SOG more gradually, permit greater flow of the SOG, and therefore provide better planarization. | */Initial bake temperature too high* |
| Longer spread cycles can cause SOG that still contains solvent to move toward the edge, reduce planarity, and create an edge bead. Shorter spread cycles (2-6 or even as low as 1 sec.) at 3000 RPM followed by a stop (i.e. 10 seconds) have resulted in better planarization on some topographies. | */Spread cycle too long* |
| While SOGs are designed to have the high spin cycle at or near 3000 RPM, spinning too quickly can decrease the planarization as centrifugal forces do not allow the SOG to fill the gaps evenly. | */RPM too high* |





# TROUBLE SHOOTING

| PROBLEM / CAUSES | SOLUTION |
| --- | --- |
| **9. RADIAL STRIATIONS** | |
| */Exhaust too high* | The increased airflow above the surface of the wafer causes the solvents in the SOG to evaporate too fast producing visible radial striations on pattern-less test wafers. In many cases, lowering the exhaust flow eliminates the striations. |
| */SOG shelf life* | Using SOG within its specified shelf life and storing/handling under the recommended conditions helps ensure that the SOG will provide optimum material performance. SOG should not be used after the "USE BY" date printed on the bottle label and should be stored under refrigeration. "Old" SOG can produce striations and a variety of film defects. |
| */Bare silicon* | New bare silicon test wafers provide the best results. If striations appear in the SOG film, it may be that the test wafer has been used and stripped many too times. |
| **10. SOG ON WAFER BACKSIDE** | |
| */Insuffcient backside IPA rinse* | A well adjusted backside rinse is necessary to remove any SOG that may have wrapped around the edge of the wafer or bounced off the cup during the spin-coat process. Glass wafers are available (from spin coater manufacturers) that allow the backside rinse to be clearly visible and permit adjustment. A clean backside is necessary to keep SOG from directly contacting the hot plates and creating particles. A clean backside is also critical for subsequent process steps (e.g., wafer positioning on steppers). |
| **11. EDGE BEAD 'TOO' LARGE/SOG WRAPAROUND** | |
| */Too much SOG dispensed* | Usually when too much SOG is dispensed, no problem occurs. Excess SOG is spun off the wafer and rinsed away. Occasionally, however, excess SOG produces an unacceptable edgebead, and the SOG wraps around to the back of the wafer. This can be a problem when subsequent process steps utilize a wafer clamping system that grips and chips the SOG edge/edgebead, which causes particles. Recommendations for dispense volumes are given in the "Spin" section of this guide. These volumes will also produce the optimum coat with the least waste. |
| */Insufficient backside IPA rinse* | (See previous section, SOG on wafer backside.) Backside rinse in proper adjustment will remove the SOG edgebead. At the proper RPM a correctly directed backside rinse stream can wrap around the edge and reduce the edgebead by dissolving it with IPA. Flow settings and adjustments vary depending on the wafer diameter and system configuration. A transparent glass wafer better enables these adjustments. |
| */Insufficient topside EBR rinse* | If edgebead is a concern, a well adjusted backside IPA rinse should be tested. when wafer handling configurations in subsequent processing systems require that SOG be removed farther away from the wafer's edge, a topside EBR accessory is necessary. The topside EBR rinse is adjusted much like the backside rinse. Experimentation will yield the best combination of adjustments and flows to optimize the recipe. |

# PARTICLE/DEFECT CHECK LIST

The following check lists represent a basic sequence for particle trouble shooting. These check lists will be helpful when used with the Trouble Shooting section. when adjusting the spin, bake, or cure settings or recipes, for the best results, use the recommended values found in this guide.

## SPIN DEFECTS (Particles in Patterns)

### INITIAL SPIN COATER VISUAL INSPECTION

- ✔ Exhaust on?
- ✔ Exhaust setting in the correct range?
- ✔ Spinner cup dirty?

### SEQUENTIAL EXAMINATION OF THE SOG PROCESS

- ✔ Spin recipe is checked:
  - Dispense correct for wafer?
  - Static/Dynamic?
  - Test wafer/Patterned wafer?
  - Delay time between dispense and spread?
- ✔ Acceptable test wafer condition?
- ✔ SOG brought to tab temperature?
- ✔ SOG bottle left in the system too long?
- ✔ Hot plates fully heated to recommended bake temperatures?
  - Hot plate temperatures too high or too low?
  - Hot plates not at settings?
- ✔ Wafers cooled down enough from the previous spin-coat-bake (multiple coats)?
- ✔ Area humidity in the correct range?
- ✔ Room/fab temperature in the correct range?

### RUNNING A PARTICLE COUNT TEST

After satisfactorily completing the Visual Inspection and the Sequential Examination, install a bottle of low particle IPA on the SOG line.

1. Dispense the IPA from the SOG line in a quantity that ensures a well flushed line and dispense tip.
2. Spin-coat a test wafer with IPA (instead of SOG), using the production recipe. Determine coater cleanliness by performing a particle count on the wafer.
3. If the particle count is high, again flush the coater with IPA for a longer time and repeat the test wafer particle count.
4. If the particle count is extremely high (several hundred), replace the SOG line with a new one. Flush the new line and repeat step 3.
5. When the system is clean, it is ready for an SOG to be installed and the particle count qualification can be performed.

## PARTICLES (Randomly Distributed)

### INITIAL SPIN COATER VISUAL INSPECTION

- ✔ Exhaust on?
- ✔ Exhaust setting in the correct range?
- ✔ Spinner cup dirty?

### SEQUENTIAL EXAMINATION OF THE SOG PROCESS

- ✔ Spin recipe is checked and correct for that process?
- ✔ Condition of test wafers acceptable?
- ✔ SOG warmed up to tab temperature?
- ✔ SOG bottle left in the system too long?
- ✔ Spinner cup rinse working/working effectively?
- ✔ Dried SOG visible on the dispense tip?
- ✔ Dispense line from SOG bottle to dispense tip too long?
- ✔ Area humidity in the correct range?
- ✔ Room/fab temperature in the correct range?

### RUNNING A PARTICLE COUNT TEST

After satisfactorily completing the Visual Inspection and the Sequential Examination, a bottle of IPA should be installed on the SOG line.

1. Dispense the IPA from the SOG line in a quantity that ensures a well flushed line and dispense tip. Clean the dispense tip as needed.
2. Using the standard spin-coat-bake recipe (with SOG dispense turned off at the dispense step), hand dispense newly opened SOG using a new pipette. Take a particle count on the test wafer. A count within specification, shows that particles are not from the SOG material.
3. Spin-coat a test wafer with IPA (instead of SOG), using the production recipe. Determine coater cleanliness by performing a particle count on the wafer.
4. If the particle count is high, again flush the coater with IPA for a longer time and repeat the test wafer particle count.
5. If the particle count is extremely high (several hundred), replace the SOG line with a new one. Flush the new line and repeat step 4.
6. When the system is clean, perform the first particle count using SOG.
7. Install a fresh SOG bottle on the spin coater, and flush the line with SOG. Using the standard spin-bake-coat recipe spin coat a test wafer and take a particle count. This will indicate a successfully flushed system, clean SOG, and a system ready for production qualification.

## COMPANY PROFILE

Honeywell Wafer Fabrication Materials (WFM), a strategic enterprise of Honeywell Electronic Materials, is an ISO-9001 certified company that develops and manufactures a full line of materials utilized in the production of advanced integrated circuits. A materials-based interconnect supplier, WFM provides solutions for advanced on-chip interconnects for both subtractive and damascene applications. Specifically, WFM produces low $\kappa$ dielectrics and sputtering targets for wiring and barrier metals, planarization materials and specialty spin-on glasses, interconnect packaging solutions such as heat spreaders and lids for thermal management, lead free solder spheres and phase change materials. For more information on WFM visit www.myinterconnect.com

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We will be recognized as the **leading supplier** of advanced on-chip interconnect materials-based solutions.

Our customers will **think of us first** because we deliver cost of ownership advantages, have **global distribution** of consistent high quality products and services and are **easy to work with.**

We will **set the standard** for quality and innovation **"from layer one to package done."**

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