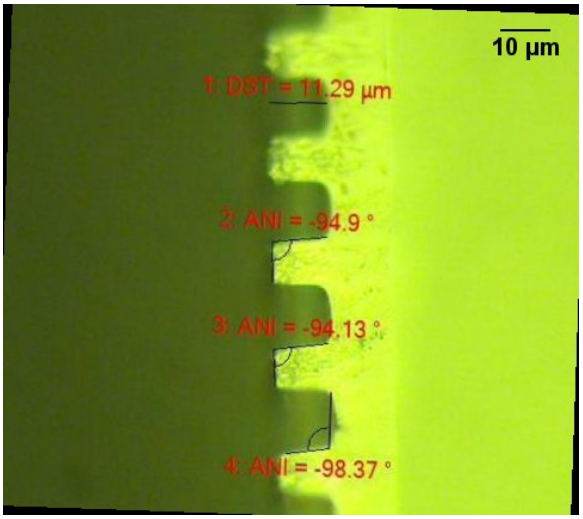
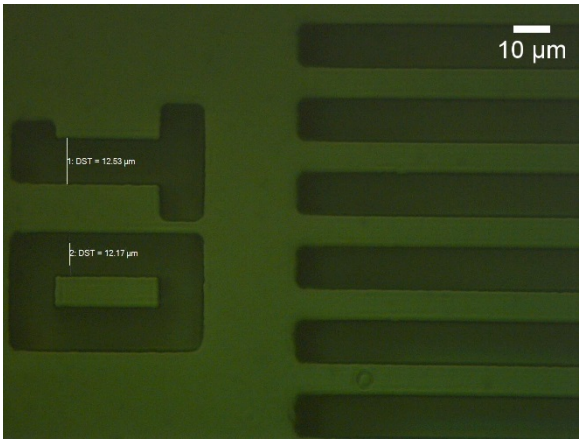
KMPR 1010 Process for Glass Wafers

KMPR 1010 Steps Protocol			
Step	System	Condition	Note
Plasma Cleaning	PVA Tepla Ion 10	5 mins	Run "OmniCoat" Receipt
Dehydration	Any Heat Plate	150°C, 5 mins	
HMDS Coating	Brewer Spin Coater	250 rpm, 250rpm/s, 5 secs; 2000 rpm, 1000rpm/s,30 secs; 0 rpm, 1000rpm/s, 8 secs.	Use "HMDS 20% spin-on" bottle
KMPR 1010 Coating	Brewer Spin Coater	500 rpm, 100rpm/s, 12 secs; 2000 rpm, 700rpm/s,35 secs; 3500 rpm, 1000rpm/s, 7 secs; 0 rpm, 1500rpm/s, 5 secs.	
Soft Bake	Any Heat Plate	100°C, 7mins	
Exposure	ABM Contact Aligner	410 MJ ("Steps exposure")[10]	
Post Bake	Any Heat Plate	100°C, 2mins	
Development	AZ 300 MIF & H_2O	45 secs/30secs/15secs [12]	
N_2 Dry			

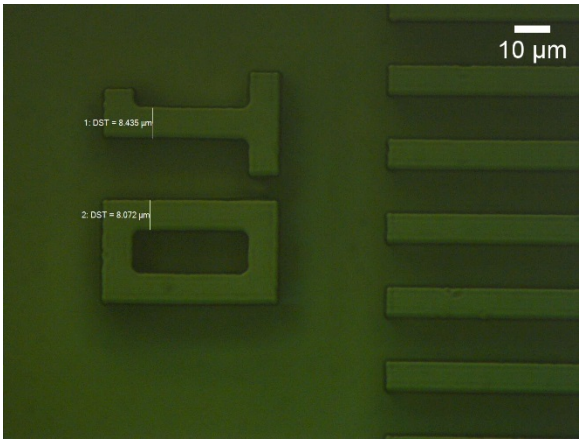
1. Place glass wafer in PVA Tepla Ion 10 and select the “Omnicoat lift up” recipe to ash the wafer. Edit the recipe and set plasma ignite to 5 minutes. This will clean the wafer and ensure better adhesion later in the process.
2. Dehydrate wafer on hot plate for 5 minutes at 150° C. After dehydration bake allow wafer to cool to room temperature.
   Note: If the contact aligner is not already on turn on the AB-M contact aligner to allow the bulb to warm up.
3. HMDS coating using the following recipe on the Brewer spin coater:
   I) Speed: 250 RPM, Ramp: 250 RPM/s, Time: 5 seconds
   II) Speed: 2000 RPM, Ramp: 700 RPM/s, Time: 35 seconds
   III) Speed: 0 RPM, Ramp: 1000 RPM/s, Time: 7 seconds
4. After HMDS spin, the wafer should look dry and clean. Remove the wafer from the chuck and rinse the bowl with acetone to remove the HMDS spill.
5. Cover the bowl of the Brewer Spin coater with Aluminum foil to avoid photoresist contact spill.
6. Place the wafer back on chuck and pour 15 to 20 mL of KMPR 1010 into center of wafer (this should cover more than 2/3 of the wafers surface)
7. Use the following recipe on the spin coater:
   I) Speed: 500 RPM, Ramp: 100 RPM/s, Time: 12 seconds
   II) Speed: 2000 RPM, Ramp: 700 RPM/s, Time: 35 seconds
   III) Speed: 3500 RPM, Ramp: 1000 RPM/s, Time: 7 seconds
   IV) Speed: 0 RPM, Ramp: 500 RPM/s, Time: 5 seconds
8. Being careful not to tilt the photoresist coated wafer, remove the wafer from the spinner and soft bake wafer on hot plate for 7 minutes at 100° C. After soft bake allow wafer to cool to room temperature before continuing process.
9. Insert i-line (365nm) filter into contact aligner. Open the nitrogen and vacuum valves to the right of the contact aligner.
10. Measure the intensity of contact aligner at each of the four corners of the stage as well as the center and take the average intensity.
11. Place wafer on the contact aligner substrate stage. Be sure to confirm that the substrate stage is below the mask stage. Place the lithography mask onto the mask stage and turn the mask vacuum and nitrogen flow on. While depressing the leveling chuck, raise the stage until relatively hard contact is made between the mask and wafer and turn the contact vacuum on.
12. Expose wafer so that the total intensity seen by the wafer is 410 mJ. To calculate exposure time, take 410 mJ and divide it by number of exposures and measured intensity. Exposures should be less than 15 seconds due to the fragile nature of the photoresist and should allow 30 seconds in between exposures to allow photoresist to cool.
13. Turn contact vacuum and nitrogen flow off. Lower the substrate stage, turn off the mask vacuum and remove the lithography mask. Now turn off the substrate vacuum. Remove the wafer and place on a hot plate to hard bake the wafer for 2 minutes at 100° C. After hard bake allow wafer to cool to room temperature.
14. Develop wafer pattern face up for 45 seconds in AZ300 MIF developer, transfer wafer to a water bath for 30 seconds, and then finally a second water bath for 15 seconds.
15. Dry with nitrogen gun.
16. Develop further as desired.

Result Expectation: for pattern dimensions larger than or equal to 10 micrometers in width and 11 microns in height, angles of approximately 95 degrees between photoresist and substrate can be achieved.

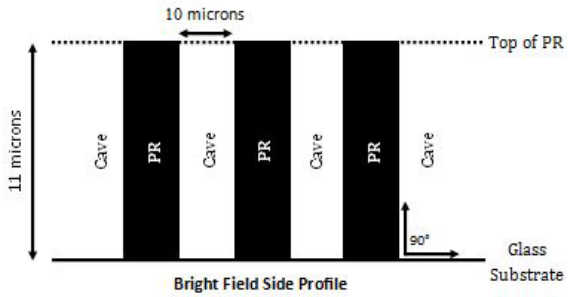


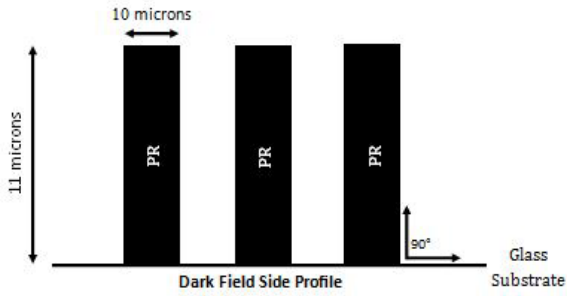


Bright Field 100x

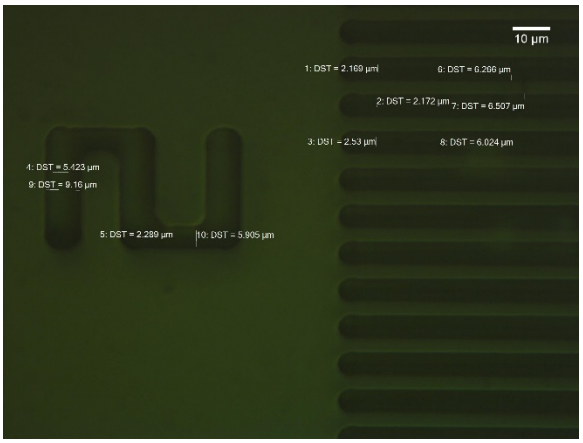


Dark Field 100x

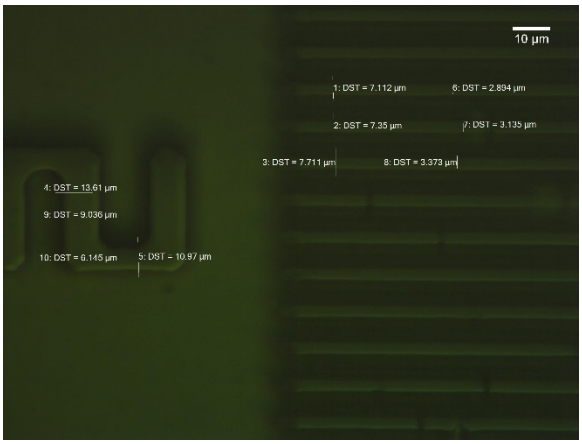




Under Exposed Images:

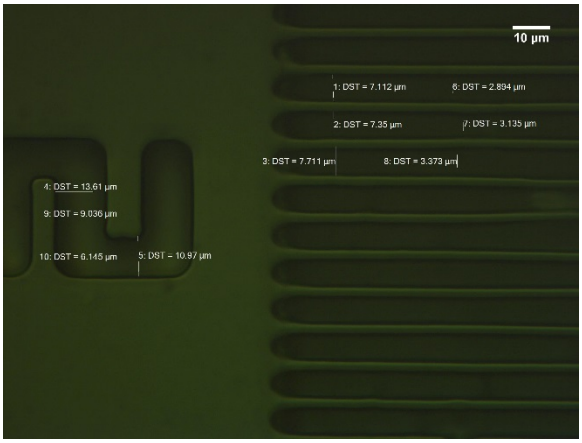


Dark field bottom focus



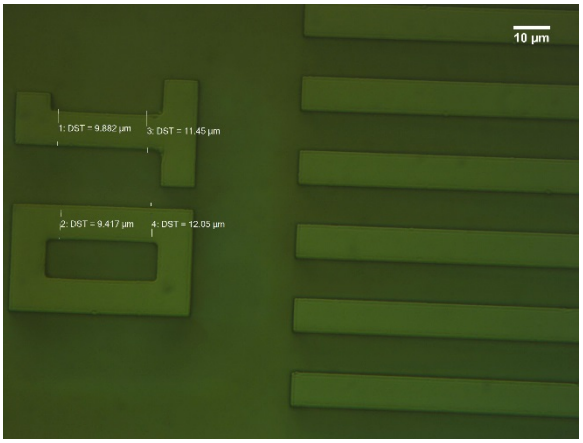
Bright field bottom focus

Dark field top focus

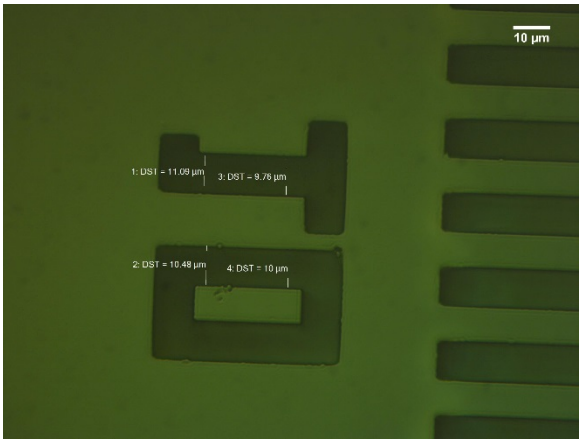


Bright field top focus

Over Exposed Images:

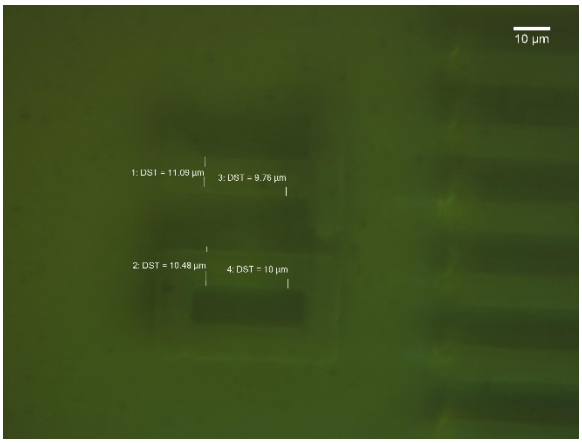


Dark field top focus



Bright field top focus

Bright field top focus



Bright field bottom focus

Discussion:

Exposure is the process of subjecting certain areas of a photoresist covered wafer to ultraviolet (UV) light. In the case of this study, glass wafers were spin coated with KMPR, a negative photoresist. Negative photoresists become cross-linked when exposed to UV light, and therefore are harder to dissolve with a developer. When developed, the areas on the wafer that have been exposed to UV light remain while the rest is washed away.

Exposure dose largely affects the quality of the wafer because it is responsible for how much energy the photoresist absorbs from UV light. If the exposure dose is too low, the energy from the UV light will not reach the bottom of the photoresist coating and the pattern will start to "peel off" during development. If the exposure dose is too high, the energy from the UV light will spread to nearby parts of the wafer causing unexposed areas to be coated by a thin layer of photoresist even after development.

An optimum exposure dose would produce approximately a 90-degree angle between the substrate and photoresist. This dosage would also produce a pattern without any photoresist in “cave” areas, an approximate photoresist height of 11 microns, and a width of 10 microns. The total optimum exposure dosage in this study was found to be 410 mJ.

Analysis

- Spin Rate
    - Standard deviations between the different wafers also appears to be consistent
- Exposure Time
    - Currently the best resolution(1µm) and aspect ratio(1:11) is being produced at a total intensity of 410 mJ
    - Increasing exposure time slightly can achieve more undercut profile
        - Reasoning: Microchem recommends 20-30% over exposure when attempting to produce an undercut profile with negative photoresist
- Pre-Procedure
    - Currently the main pre-procedure process is dehydration, a few processes have also implemented the plasma cleaning and HMDS coating which we believe could be beneficial to improving adhesion.

- Development
    - We found that the methods of development could be adjusted upon different thickness and sizes of pattern.
    - The KMPR data sheet calls for an immediate spray rinse after development instead of soaking the wafer in a water bath. This spray rinse might be more effective at removing developer from between photoresist areas. However, it may also remove the pattern if the spray is not gently enough.