In order to provide more support to our customers, Cost Effective Equipment, LLC. decided to run extensive testing to achieve less than 1% total thickness variation for some commonly used materials on Cost Effective Equipment Cee® 300 X spin coaters. The data from these experiments are intended as a starting point for our customers and will vary in different locations and environments. The testing included four different materials and the experimental design will look at several different variables in order to try to find the optimal coat uniformity on 300 mm silicon wafers. The variety of variables consisted of primarily the following; a pre-wet step, snap spin, ramp to spin of 1 second or of 5 seconds, exhaust, and static or dynamic dispense. Testing of these variables will determine which ones have the greatest impact on the uniformity and when optimized will provide a best-known method for each material.

Shipley 1813

Shipley 1813 photoresist was tested and a best-known method was determined. The best-known method consists a ramp to spin of 1750 rpm/s, exhaust of 15%, and static dispense. For this experiment the spin speed was 1750 rpm to achieve a 1.4-micron thick coating. This recipe is shown in Table 1.

Step	Velocity (rpm)	Ramp (rpm/s)	Time (s)	Dispense	Exhaust (%)
Dispense	0	1750	27	1	15
Spin	1750	1750	45	None	15

Table 1: Optimized recipe for Shipley 1813 photoresist

Along with these parameters, all the ports on the lid were sealed to ensure a solvent rich environment in the bowl. A sealed lid prevents material from drying too quickly on the wafer and gives a more even coat. 20 ml of material was also dispensed for 25 seconds with an IDI Model 450 pump in order to achieve consistent dispenses and obtain reliable data. After the spin process, the wafers were baked at 150° C for 1 minute on a Cost Effective Equipment Cee® Model 11 bake plate.

Using the process above, a 0.61% total thickness variation was achieved on 300 mm silicon wafers. Total thickness variation was measured using a Foothill Instruments KV-300 B film thickness tool. The average thickness was 1.28 microns. Statistical analysis showed that the variables that affect the uniformity of the coat the most for this process are exhaust and ramp to spin.

AZ 4620

Another material tested was AZ 4620 photoresist. The best-known method found was a static dispense, a spread spin, and a final spin. All ports on the lid were closed and an IDI 600 was used for dispense. During the static dispense, 30 ml of AZ 4620 was dispensed for 30 seconds onto a wafer. After the dispense, the wafer underwent a spread spin. A spread spin allows the material to cover the entire wafer before the final spin. In this case, the spread spin was at 500 rpm with a ramp of 2000 rpm/s for 10 seconds. Lastly, the final spin, which determines the thickness of the coat, was preformed for 60 seconds at 2000 rpm. This recipe is shown in Table 2.

Step	Velocity (rpm)	Ramp (rpm/s)	Time (s)	Dispense	Exhaust (%)
Dispense	0	2000	30	1	20
Spread	500	2000	10	None	20
Final Spin	2000	2000	60	None	20

Table 2: Optimized recipe for AZ 4620

After the spin process, the wafers were baked at 110° C for 90 seconds on a Cost Effective Equipment Cee® Model 11 bake plate.

Using the process above, a 0.63% total thickness variation with an average thickness of 9.11 microns was achieved on 300 mm silicon wafers. The total thickness variation was measured using a Foothill Instruments KV-300 B film thickness tool. Statistical analysis showed that the variables that affect the uniformity of the coat the most for this process are exhaust and spread spin.

SU-8 3025

The third material tested was SU-8 3025 permanent epoxy negative photoresist. The best-known method found was a static dispense, a spread spin, and a final spin. All ports on the lid were closed and an IDI 600 was used for dispense. During the static dispense, 30 ml of SU-8 3025 was dispensed for 30 seconds onto a wafer. After the dispense, the wafer underwent a 500 rpm spread spin. A spread spin allows the material to cover the entire wafer before the final spin. Then a final spin was preformed for 45 seconds at 1750 rpm. This recipe is shown in Table 3.

Step	Velocity (rpm)	Ramp (rpm/s)	Time (s)	Dispense	Exhaust (%)
Dispense	0	500	30	1	15
Spread	500	500	15	None	15
Spin	1750	1750	45	None	15

Table 3: Optimized Recipe for SU-8 3025

The wafer then went to a Cost Effective Equipment Cee® Model 11 bake plate to bake for 13 minutes at 95° C.

Using this process, the coating had a 1.81% total thickness variation with an average thickness of 39.49 microns on 300 mm silicon wafers. These measurements were done on a Foothill Instruments KV-300 B film thickness tool. Further analysis of this process showed that the variables that affect the uniformity of the coating the most are exhaust and spread spin.

AZ 5214

The coating process for AZ 5214 image reversal photoresist was also optimized. The best-known method found was a static dispense, a spread spin, and a final spin. All ports on the lid were closed and an IDI 450 was used for dispense. During the static dispense, 20 ml of AZ 5214 was dispensed for 27 seconds onto a wafer. After the dispense, the wafer underwent a 500 rpm spread spin. Then a final spin was preformed for 30 seconds at 2000 rpm. This process is shown in Table 4.

Step	**Velocity (rpm)**	**Ramp (rpm/s)**	**Time (s)**	**Dispense**	**Exhaust (%)**
Dispense	0	2000	27	1	15
Spread	500	2000	5	None	15
Spin	2000	2000	30	None	15

Table 4: Optimized Recipe for SU-8 3025

After the spin process, the wafers were baked at 110° C for 50 seconds on a Cost Effective Equipment Cee® Model 11 bake plate.

Using the process above, a 0.84% total thickness variation with an average thickness of 1.64 microns was achieved on 300 mm silicon wafers. These measurements were measured using a Foothill Instruments KV-300 B film thickness tool. Statistical analysis showed that the variables that affect the uniformity of the coat the most for this process are exhaust and ramp to spin.