JOHNSEN RAHBEK's CHUCKING CAPABILITY STUDY

Sriram Viswanathan, Freddy Granados
Cyrpress Semiconductor, Applied Materials
2401 East 86th Street, Bloomington, Mn 55425
10,000Spectrum Drive, Austin, Tx 78717

ABSTRACT

Customer devices require robust hardware control to provide stable process performance on less than 130nm node technologies. Wafer temperature control using high backside helium pressure in dual zone Johnsen Rahbek's (ESC) using low power process steps presents a challenge. Tests were done in a 200mm chamber narrow gap using a simplified gas distribution plate and modified cathode. High backside helium pressure settings can be achieved across multiple chambers if chucking hardware is properly calibrated and ESC's are manufactured with tight tolerances. High backside He pressure is required to control process wafer temperature which is important for CD etch bias and selectivity. Variability of ceramic ESC performance across multiple chambers resulted in a chuck capability study based on backside pressure set-points, chucking voltages, and different power levels. Results obtained demonstrate performance can vary significantly from chamber to chamber. Tight tolerance control of electrostatic chuck materials, RF match calibration, and back side He setup will decrease chamber to chamber chucking variability.

OBJECTIVE

Being able to operate at high backside helium pressure regimes is critical for high power process steps. If low process power level (<500w) is being used, the recommendation is to run an experiment to understand process impact at high and low backside pressure set points. Primary objective of experiment was to identify voltage pop (Vp) as depicted in Figure #1.

RESULTS

Identification of Vp across multiple systems helps establish 3σ variation of Vp. Backside He and tool were found to have a significant effect on Vp. Surprisingly, RF power was not a significant variable affecting Vp. Figure #2 is a graphical representation of residuals after subtracting effect of BsHe to determine within tool variation. Analysis suggests that one tool is different compared to other tools. Figure #3 represents Vp linear fit models as a function of backside He for the three tools. Model results conclude all three fits are good. Similar model fit tools will be used to calculate expected variation in Vp at a given BsHe set point. Estimation of Vp spec limits for each tool is calculated by using residuals from Vp vs BSHe model. Calculated residuals, therefore, do not have effect of tool or BSHe (only 2 significant effects). Taking worst case scenario, best performing tool is not used in sigma calculation.

- *Sigma of residuals for CMI tool (s1) ~ 38.92*
- *Sigma of residuals for demo tool (s2) ~80.1*
- Expected 3*Sigma for Vp (3*sVp)= SQRT{(s12+s22)/2} ~ 189V.

Thus, Vp can be expected to vary ~ ±189V. The range for Vp is therefore ~378V.

CONCLUSION

Chucking force variation of 200mm reactor can be minimized using proper hardware setup. Understanding hardware differences and establishing control limits that identify rogue e-chucks is critical. Customers are and will utilize extreme back side helium pressure set points at wide range of power levels. Conclusion of experiment is that theoretical and actual results are not consistent e-chuck to e-chuck. Experiment results conclude manufacturing tolerances are critical, best known methods process for identification of abort voltage boundary conditions, and standardized setup procedures for hardware.

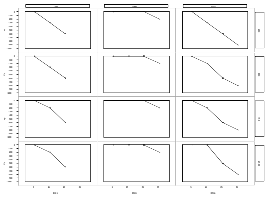

Figure #1

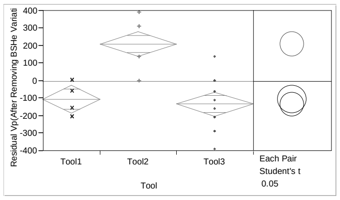

Figure #2

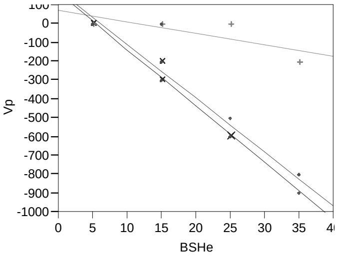

Figure #3