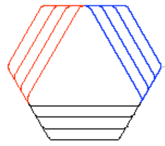
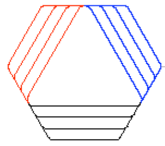


Third Party Resist Supplier Evaluation of TriFact Solutions, Inc. DI Water Heater Model TFS 4000-TP Unexposed Resist Defects



Project Objective

- **Study the effect of a heated deionized (DI) water rinse on the formation of post develop defects on unexposed resist defects.**

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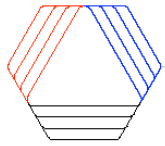
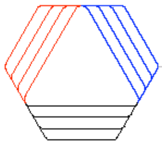


Equipment

- TEL Mark 8 coat/develop tool
- TriFact Solutions DI water Heater Model TFS 2000-TP
- Tridak Low Volume Dispense Assembly
- ASML PAS5500/850 stepper
- K-T8100 Top Down CD SEM
- K-T2135 Defect Inspection tool
  - Narrowband illumination with a Hg-Xenon light source and filtered wavelength.
  - Inspection wavelength around 580nm.



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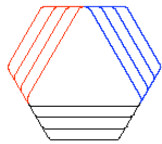
KLA-Tencor2135 Defect Inspection Parameters

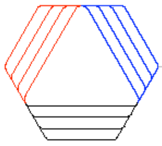
- KLA2135 Defect Inspection tool
  - Pixel setting: **0.25** µm
  - Inspection Mode: Array
  - Threshold: 20
  - Filter set: f2
  - Inspected area: **69.07** sq./cm. Patterned Resist Area
    35.85 sq./cm. Unexposed Resist Area
    35.06 sq./cm. Bulk Exposed Resist Area



Results Summary Table
Unexposed Resist Area Defects

DI Water Rinse Time	Standard Rinse Temperature		Heated Rinse Temperature	
	Defect Count	Defect Density (defects/sq. cm.)	Defect Count	Defect Density (defects/sq. cm.)
20 sec.	224	6.25	110	3.07
20 sec.	253	7.06	90	2.51
20 sec.				
40 sec.	177	4.94	134	3.74
40 sec.	153	4.27	91	2.54
40 sec.			98	2.73
60 sec.	71	1.98	77	2.15
60 sec.	70	1.95	77	2.15
60 sec.	81	2.26	75	2.09
80 sec.	116	3.24	63	1.76
80 sec.	141	3.93	67	1.87
80 sec.			88	2.45

The heater setting is at 40°C but the actual temperature at the DI water rinse nozzle is 36°C. This is due to the length of exposed tubing between the heater assembly and the dispense tip. For this evaluation, the heater was not able to be configured closer to the DI water dispense nozzle.



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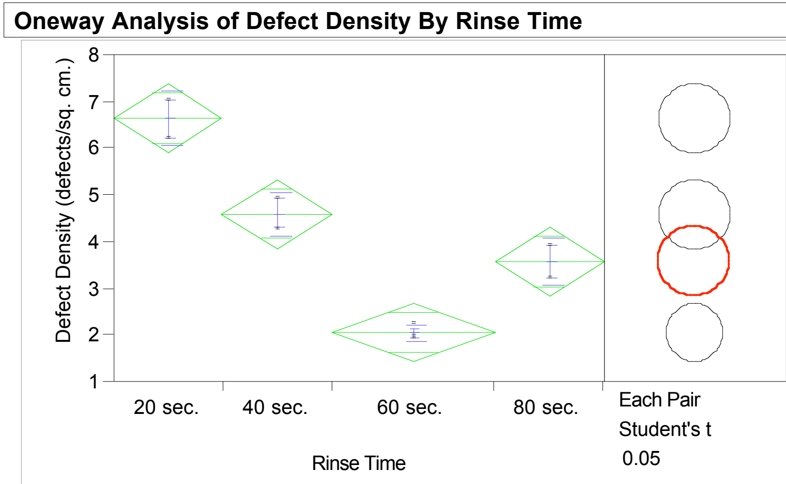
JMP Analysis Results of Defect Density's Unexposed Resist Area Defects

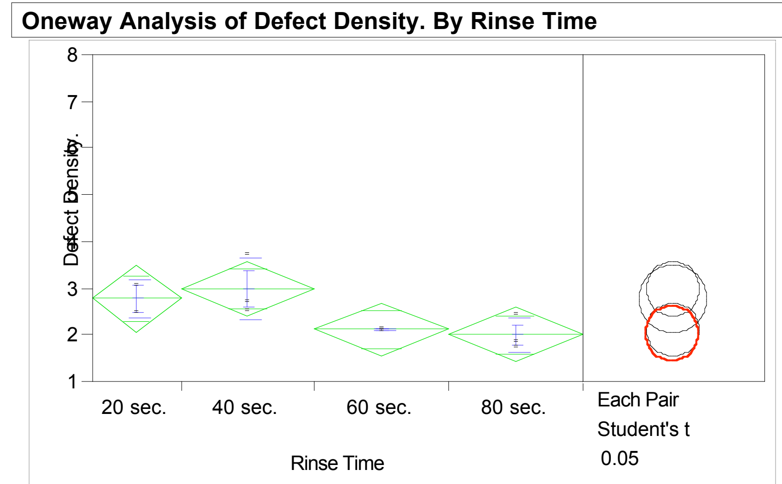
Standard DI Water Rinse Temp. (21°C)



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
20 sec.	2	6.65500	0.572756	0.40500	1.509	11.801
40 sec.	2	4.60500	0.473762	0.33500	0.348	8.862
60 sec.	3	2.06333	0.170978	0.09871	1.639	2.488
80 sec.	2	3.58500	0.487904	0.34500	-0.799	7.969

Heated DI Water Rinse Temp. (40°C)



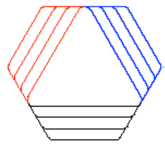
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
20 sec.	2	2.79000	0.395980	0.28000	-0.768	6.3477
40 sec.	3	3.00333	0.645006	0.37239	1.401	4.6056
60 sec.	3	2.13000	0.034641	0.02000	2.044	2.2161
80 sec.	3	2.02667	0.370720	0.21404	1.106	2.9476

With A standard rinse temperature, increasing the rinse time reduces post develop defects.

A heated DI water rinse produced lower counts at a shorter rinse and continues to maintain or reduce that count with extended rinse time. A heated DI water rinse at 20 sec was equivalent to a standard rinse at 60 second.

Note: 40°C is the set point temperatures on the heating assembly. Actual temperature at the Nozzle is 36°C.



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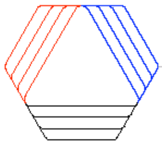
Wafer Maps
Unexposed Resist Area Defects

	Rinse Time 20 sec.	Rinse Time 40 sec.	Rinse Time 60 sec.	Rinse Time 80 sec.
Standard Rinse Temp (21°C)				
Heated Rinse Temp (40°C)				



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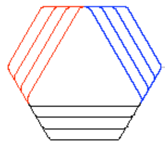
Classification Codes
Unexposed Resist Area Defects

- **Sm Dark – Small dark point defects (<0.25μm in size).**
- **Sm Bright – Small light point> defects (<0.25μm in size).**
- **Rnd/Med Dark – Round and darker than the background.**
- **Rnd/Med Bright – Round and lighter than the background.**
- **Type 44 – Round bright center with large, darker halo.**



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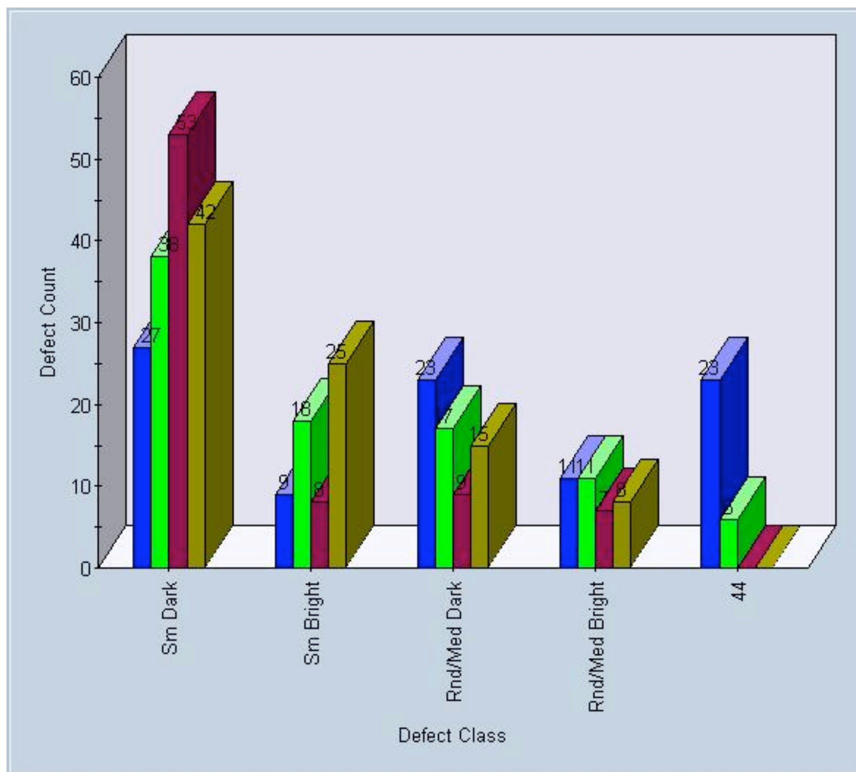
Pareto Charts
Unexposed Resist Area Defects

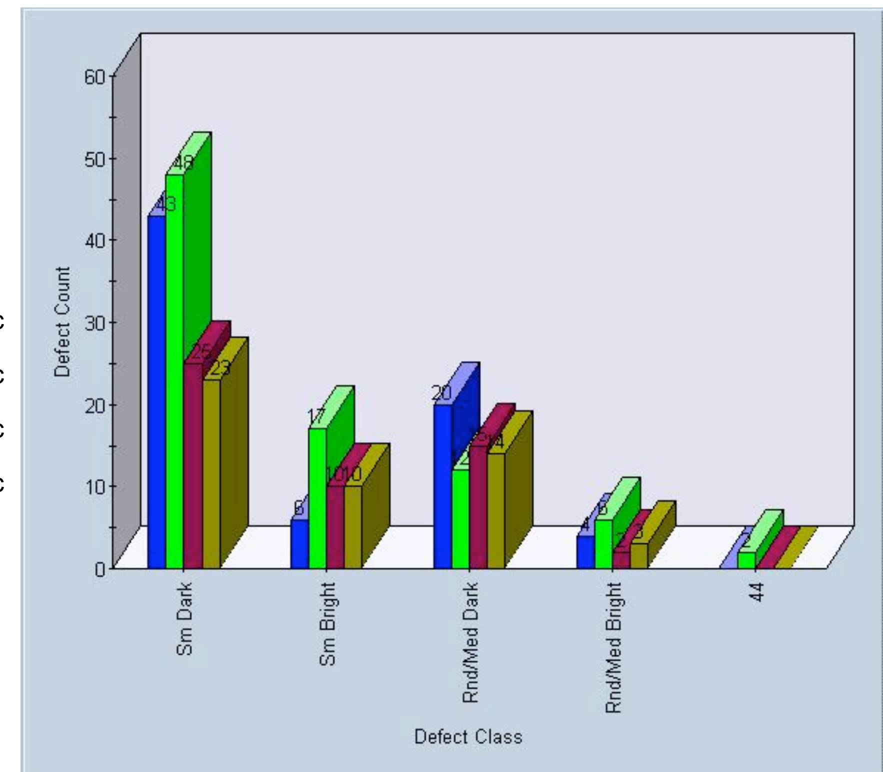
One wafer classified per process condition. Up to 100 defects classified per wafer.

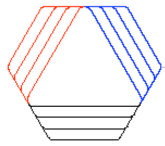
Standard Rinse Temperature (21°C)



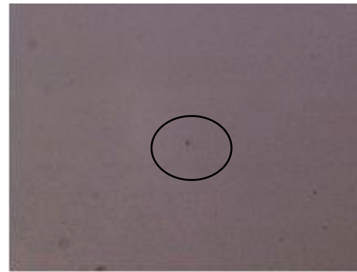
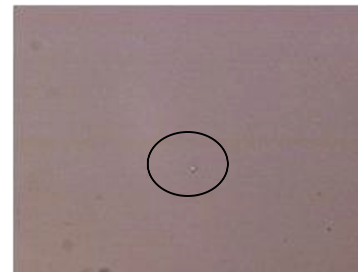
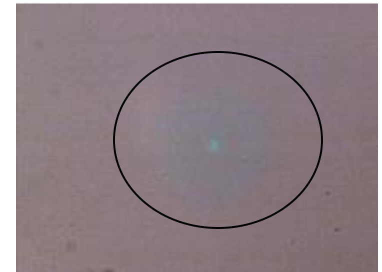
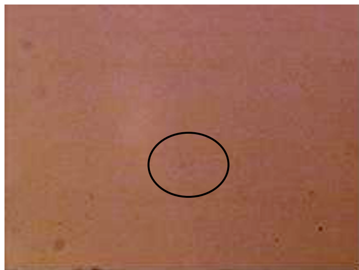
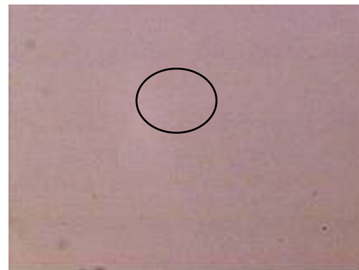
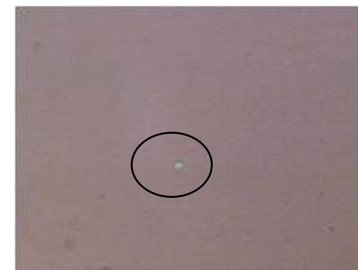
Rinse Time
20 sec
40 sec
60 sec
80 sec

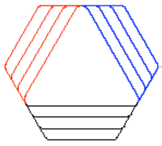
Heated Rinse Temperature (40°C)





Optical Images of Defect Types
Unexposed Resist Area Defects

Sm dark	Sm bright	Rnd/Med Dark	Rnd/Med bright	Type 44
				
				



Results Summary
Unexposed Resist Area Defects

- **Analysis of the defect density's show:**
  - **Using a standard rinse temperature, increasing the rinse time reduces post develop defects.**
  - **A heated DI water rinse produced lower counts at a shorter rinse and continues to maintain or reduce that count with extended rinse time.**
  - **A heated DI water rinse at 20 sec was equivalent to a standard rinse at 60 second.**

- **Review of defects show:**
  - **Using a standard rinse temperature, increasing the rinse time saw in increase in Sm Dark and Sm Bright defects and a reduction in Rnd/Med darks and Type 44 defects.**
  - **A heated DI water rinse reduced Sm Dark and Rnd/Med Dark defects.**