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

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Project Objective

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

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Equipment

- TEL Mark 8 coat/develop tool
- DI water Heater Model TFS 4000-TP
- ASML PAS5500/300 stepper
- KLA-Tencor8100 Top Down CD SEM
- KLA-Tencor2135 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:	**0.39** μm
Inspection Mode:	Random
Threshold: 20	
Filter set:	f2
Inspected area:	**21.26** sq./cm. Unexposed Resist Area
	23.74 sq./cm. Bulk Exposed Resist Area

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Results Summary Table
Un-exposed Resist Area Defects

DI Water Rinse Condition	DI Water Rinse Temperature (C) Set (actual at Tip)	Sample A		Sample B	
		Defect Count	Defect Density (defects/sq. cm.)	Defect Count	Defect Density (defects/sq. cm.)
Standard	21	1250	58.80		
Standard	21	572	26.90	303	14.25
Standard	21	531	24.98	134	6.30
Heated	40 (36)	40	1.88	121	5.69
Heated	40 (36)	37	1.74	99	4.66
Heated	40 (36)	34	1.60	66	3.10
Heated	55 (46)	43	2.02	64	3.01
Heated	55 (46)	159	7.48	80	3.76
Heated	55 (46)	80	3.76	50	2.35

The “Set (actual at Tip)” refers to what the temperature the heater assembly is set at versus what the actual temperature of the water at the DI water dispense nozzle tip is. In this case, the heater is set 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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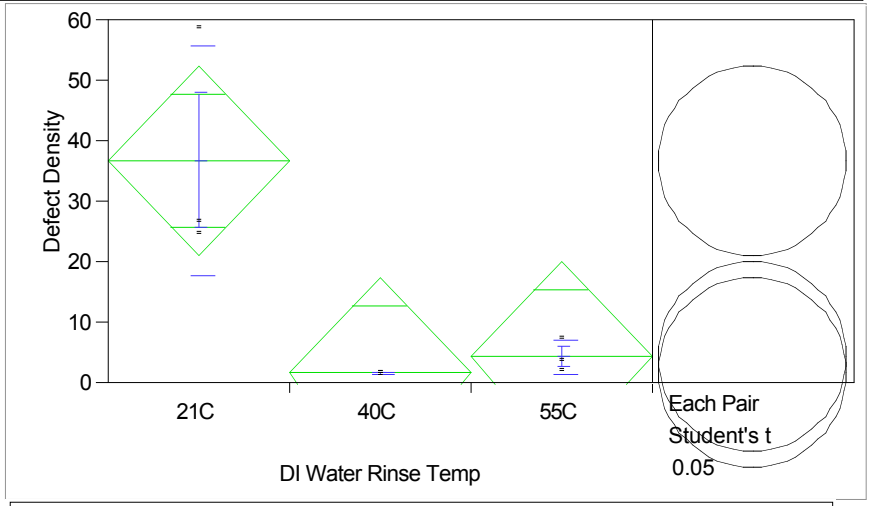
JMP Analysis Results of Defect Density's Unexposed Resist Area Defects

Sample A

Oneway Analysis of Defect Density By DI Water Rinse Temp

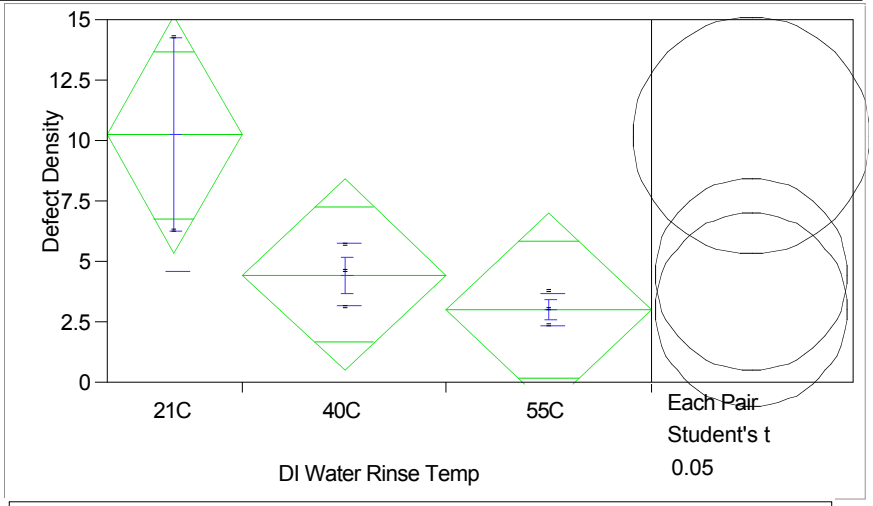


Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
21C	3	36.8933	18.9960	10.967	-10.30	84.082
40C	3	1.7400	0.1400	0.081	1.39	2.088
55C	3	4.4200	2.7892	1.610	-2.51	11.349

Sample B

Oneway Analysis of Defect Density By DI Water Rinse Temp



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
21C	2	10.2750	5.62150	3.9750	-40.23	60.782
40C	3	4.4833	1.30401	0.7529	1.24	7.723
55C	3	3.0400	0.70548	0.4073	1.29	4.793

- Shown are the defect results for the comparison between Sample A and Sample B resist processed using a DI water rinse temperature of 21°C, 40°C and 55°C.
- A 40°C and 55°C DI water rinse proved to have a significant effect in reducing the defect density.
- Note: 40°C is the set point temperature on the heating assembly. Actual temperature at the Nozzle was 36°C.

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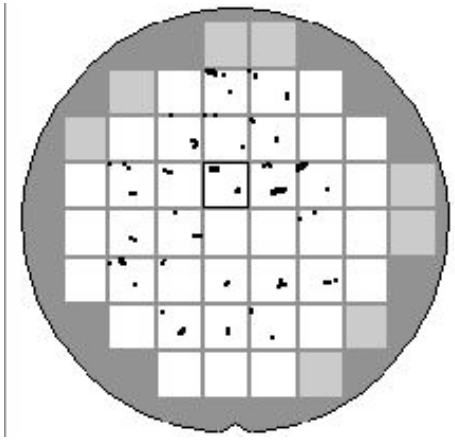
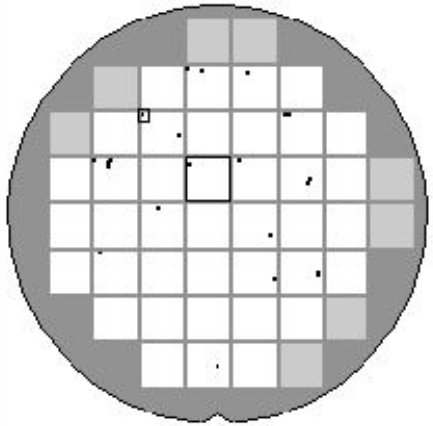
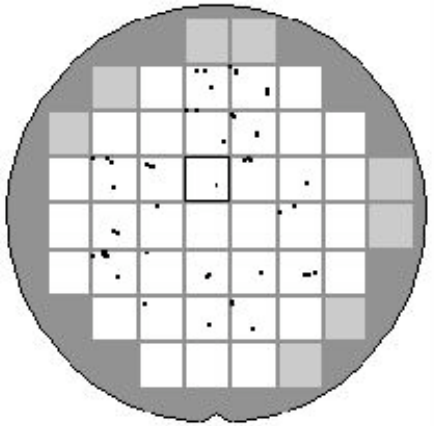
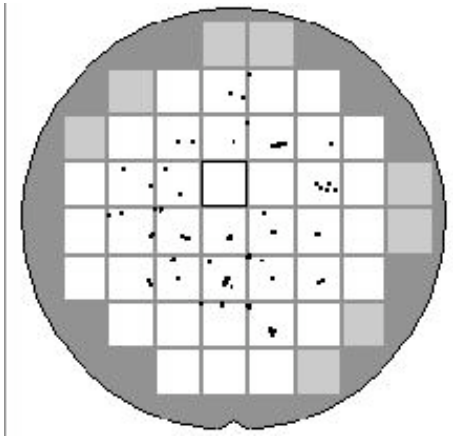
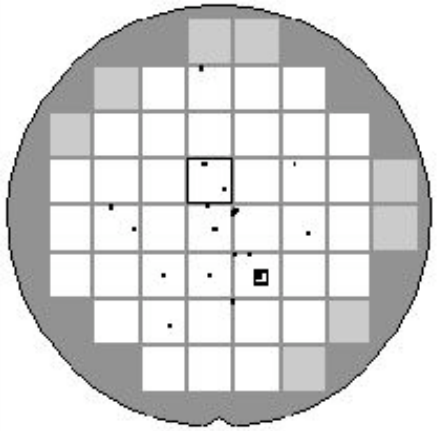
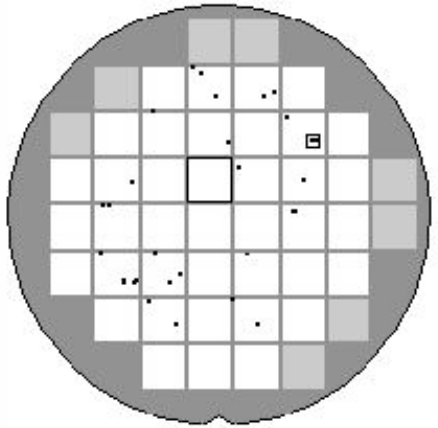
Maps Patterned Unexposed Resist Area Defects

	Standard Rinse (21°C)	Heated Rinse (40°C)	Heated Rinse (55°C)
Sample A			
Sample B			

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Classification Codes

- Type 2 – Blob Defects <0.5µm in size.
- Type 3 – Round and darker than the background.
- Type 4 – Blob Defects >0.5µm in size.
- Type 6 – Irregular shape and lighter than the background.
- Type 9 – Satellite Defects.
- Type 13 – Contrast (false) defects.

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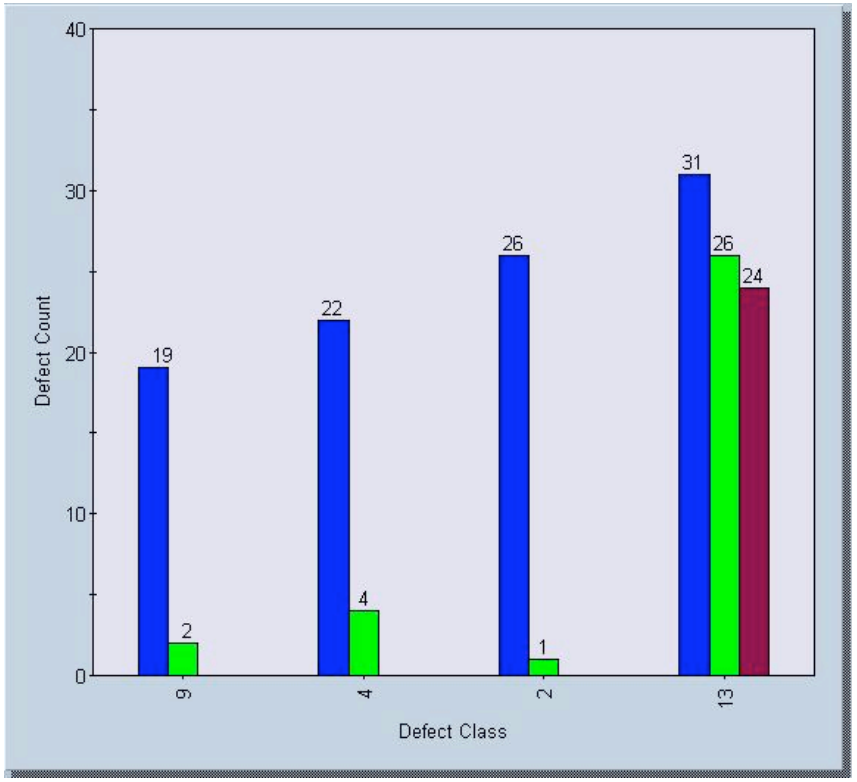
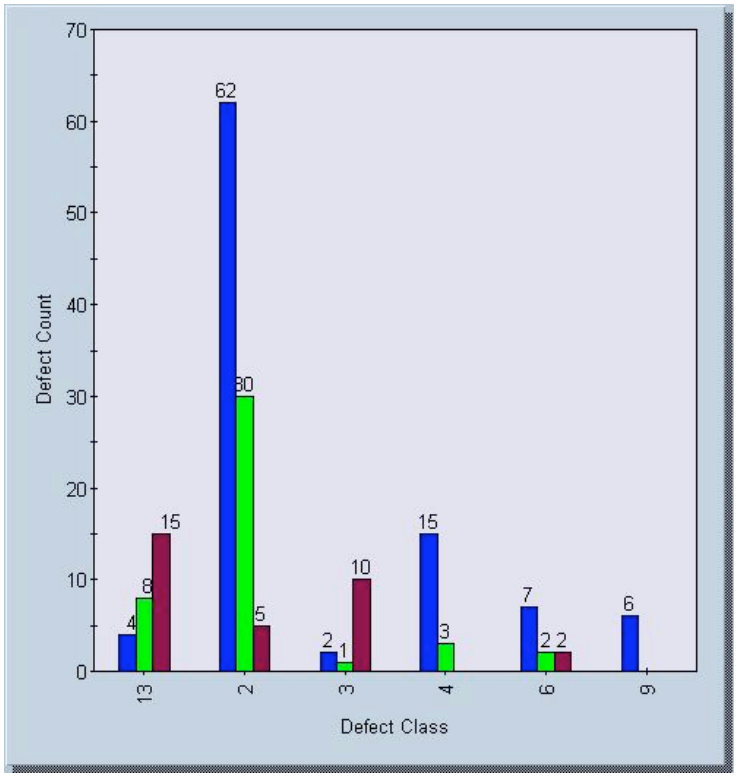
Pareto Chart

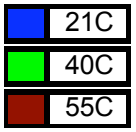
Sample A



Sample B



One wafer classified per process.



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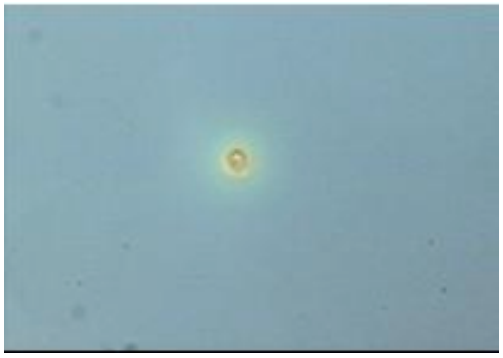
Optical Images of Defect Types

Type 2

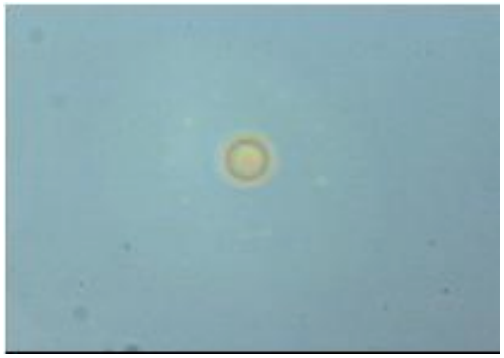
Type 3

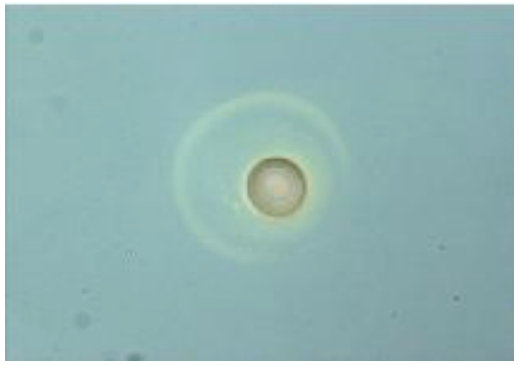
Type 4

Type 6



Type 9





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Results Summary
Unexposed Resist Area Defects

- Analysis of the defect density's show the use of a heated DI water rinse has a significant effect on the reduction of post develop defects for both Sample A and Sample B.

- Review of defect type for Sample A, based on classification of one wafer per test condition, showed
  - A 40°C DI water rinse significantly reduced Defect Types 2, 4 and 9.
  - A 55°C DI water rinse virtually eliminated Defect types 2, 4 and 9.

- Review of defect types for the Sample B, based on classification of one wafer per test condition, showed
  - A 40°C DI water rinse significantly reduced Defect Types 2, 4 and 9.
  - A 55°C DI water rinse significantly reduces Type 2 defects and virtually eliminated Defect types 4 and 9. There was an increase in Defect Types 3 and 13.