

La Analitica

for diffusion process

(Purpose Of Creation)

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STATEMENT OF CREATION

An analytics tool is constituted to reconstruct the existing pseudo-active system into an easier, effective and more interactive system and it will give the user an entirely new perception to analyze data which helps them to extract optimum output from the machine.

PROBLEM STATEMENT

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Every now and then, we encountered with the news of Electrical Rejection(ER) propelled by junctionless cells being printed in masses and diminishing the overall average efficiency to ground. Not only junction-less cells but also Out Of Specification Rsheet values of diffused wafers is responsible for uncontrollable techno-economic havoc; thus it is necessary to put a full stop or terminate such disaster at an early stage to avoid any complication at later stage.

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Problems Related To Diffusion Cluster

3.1

Inefficient Utilization of Manpower

- One production operator is entitled to perform offline measurement of Rsheet using SheRRscan tool in every shift and it took him almost half a shift to perform Rsheet measurement and data entry to SPC of 175 wafers(5 samples/tube/machine: Bay-1) or $175 \times 3 = 525$ data points.
- By putting Operator in such recurring and non-mechanized activity, he might lose confidence in his daily activities.

3.2

Non-Utilization of Resources

- Though we have the provision of measuring inline Rsheet through Semi Lab tool installed at the machine, we are using offline metrological tool for Rsheet measurement analysis.
- BWe used to take a decision to change or modify recipes based on manual data enter in SPC by the operator.

3.3

False/Fake Data Entry

- Operators often enter false/fake data deliberately or mistakenly into SPC which will cause trouble in analyzing data to maintain and improve the process.

3.4

Wastage of Material

- **Multicrystalline wafer Scenario** Under full production mode, Operators* has to take 525 wafers per day (175 Wafers/Shift) from the machine and perform manual Rsheet measurement on the offline tool and these wafers are then kept aside to process separately under observation after verification of PN junction orientation of wafers. **Chance of reversely oriented wafer printed contributed to %ER is not ignored in such case.**
- **Monocrystalline wafer Scenario** Operator has to take at least 200 wafers per day from different PERC, Std. MONO & Bifacial Tool to measure Rsheet on the offline tool and these wafers are **not allowed to process further due to the visibility of scratches on the rear surface of the**

3.5

Risk of Breakage

- Too many manual handling will lead to a risk of breakage.

3.6

Exhaustive use of Meteorological tool

- Excessive use of offline measurement tool will affect the life of different main/spare parts of the tool and increase maintenance cost. For e.g. lid of SheRRscan enclosure has been broken and repaired several times due to repeatedly open-close operation.

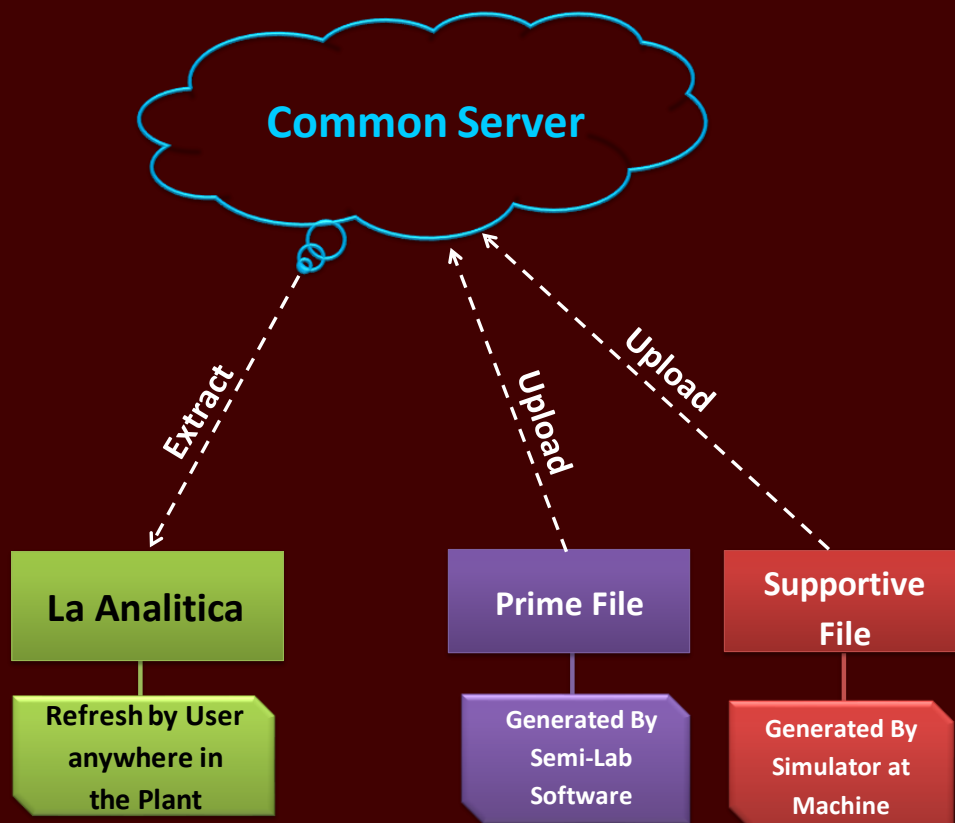
* Wafers taken by production operators are only taken into consideration, Quality and Process Operators and their individual sampling frequencies are excluded from the count.

- The problems are gradually increasing day by day and a stable system is required to address the issue.
- Our approach should be focused on minimizing manual work through utilization of existing Inline Rsheet tool for better control over Diffusion system.

- Entire system is categorized into two segments.

- 1) Prime System (La Analitica)
- 2) Supportive system (Tube number Simulator)

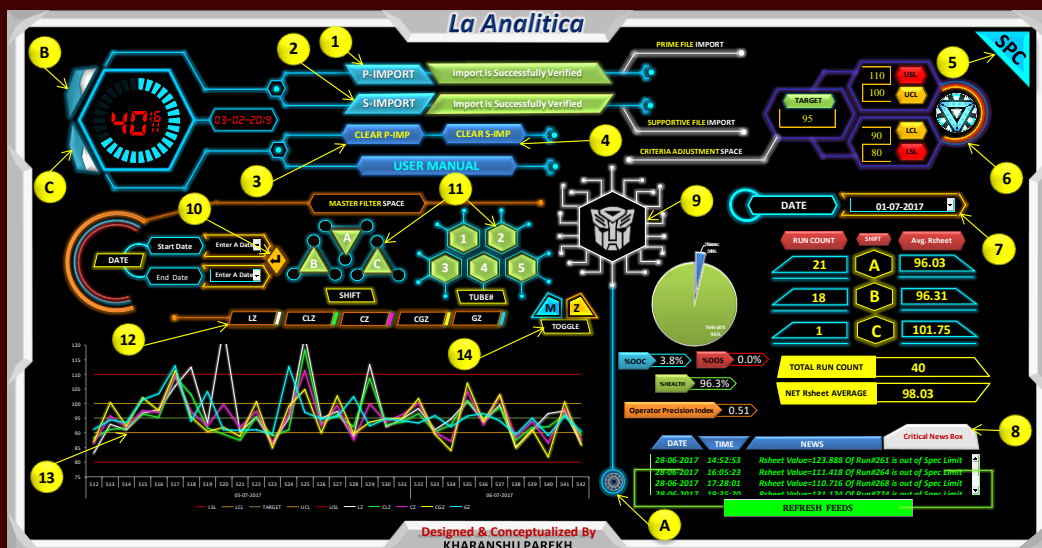
How It Works?



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Outlook of LaAnalitica

OVERVIEW



10 Date Duration Filter Button
Helps user to filter Rsheet Data between Two Dates.

11 Shift/Tube# Selection Button
Helps to select appropriate Shift /Tube# for micro Analysis

12 Zones Selection Switches
Helps to select different Zones for Zone wise Rsheet Analysis.

13 Rsheet Graph
Helps to Indicate Current Trend and performance of process.

14 Toggle Switch
Helps user to switch between Avg. Rsheet trend & Zone wise Rsheet Trend.

A Zoom IN/OUT Button
Helps user to sneak IN & sneak OUT of Rsheet Grap.

B Clock Play Button
Helps to active Ticking of Digital Clock.

C Clock Pause Button
Helps to inactive Ticking of Digital Clock.

1 P-IMPORT Button
Helps to import Prime data File which contains Rsheet Data.

2 S-IMPORT Button
Helps to import Supportive data File which contains Tube# record.

3 CLEAR P-IMP Button
Helps to Clear Prime Import so that user can Import another file.

4 CLEAR S-IMP Button
Helps to Clear Supportive Import so that user can Import another file.

5 SPC Generator Button
Helps to Generate SPC in excel format for further analysis.

6 Criteria Adjustment Button
Helps to adjust Upper and Lower limit criteria.

7 Day Data Analyzer
Helps to indicate Approx. count and Avg. Rsheet Day/Shift wise with %OOC and %OOS per Day.

8 Critical News Box Space
Helps user to inform about out of Spec. Run with Pop-Up and Log.

9 Autoboot Analyzer Button
Helps to analyze and update graph corresponding to Import files.

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Features of LaAnalitica

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Digital Clock

This feature helps the user to record time of last Data Updation.

Zoom IN/OUT Button

2

This feature helps the user to visualized Enlarge View of Rsheet Graph.

3

Criteria Adjustment Space

This feature helps the user to Change Specification Limits of Process.

4

Date Duration Filter

This feature helps the user to filter Rsheet trend between Two Dates

Shift/Tube# Selection Switch

5

This feature helps the user to filter data Shift/Tube# wise

6

Toggle Switch

This feature helps user to switch between Avg. Rsheet trend & Zone wise Rsheet Trend

Shift/Tube# Selection Switch

7

This feature helps the user to alert about Out Of Spec. value of Rsheet

8

Operator Precision Index Indicator

This feature helps the user to identify Precision of Operator working at Diffusion

SPC Generator

9

Helps the user to Generate SPC in excel format for further analysis.

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Day data Analyzer

Helps to indicate approx. count and Avg.Rsheet Day/Shift wise with %OOC and %OOS per Day

To know more about functionality of Features , kindly refer the User Manual

8.1 It Reduces Manual Handling

La Analitica is extracting data directly from the inline measurement tool hence no need to take diffused samples for offline measurement and this facility will allow a user to reduced manual handling.

8.2 Reduces Wafer wastage and breakage Occurrence

Handling wafers manually for measurement will always increase the risk of breakage which ultimately caters the wastage of material as well as money.

8.3 Reduces Manpower Involvement

No manpower will require for the offline measurement of the wafer as analytics algorithm of La Analitica is capable of display real-time Rsheet value on the Computer screen.

8.4 Increase the Authenticity of Data

The authenticity of data is an integral part of process control and this tool is strong enough to offer machine-generated data which is authentic enough to rely on without any human interruption.

8.5 Helps to Monitor Process in Real Time

La Analitica has real-time Rsheet monitoring feature to visualize the trend of the process by providing a trend of Average Rsheet as well as Zone wise Rsheet distribution of last 30 Runs.

8.6 Alarm Intimation

Night-watch feature of tool pay attention to every unhealthy output from the machine and gives intimation in terms of a message on the screen while refreshing data. This feature will allow the user to take corrective action.

8.7 Helps to Analyse Alarm History

Alarm protocol in Critical Alarm Window will help a user to analyze the frequency of occurrence of a fault with Occurrence Time and Date.

8.8 SPC Generator

Provision of SPC generator will allow a user to generate SPC in familiar Excel format which ultimately enables a user to apply their own analytics and logic in their own way.

8.9 Provide approximate Production Counter and Rsheet /Shift/Day

Day Data Analyser will provide approximate production counter by multiplying Number of Run with 1000 as well as it will offer average Rsheet in accordance with Run Count/Shift/Day.

8.10 User can Dive into Retrospect

A user can visit and revisit the previous data archived in the Text file (generated by the inline measurement tool) by using the Date Filter feature of La Analitica

8.11 Flexibility in Selection of Specification

Provision of Specification limit (LSL, LCL, Target, UCL, USL) is granted to a user so they can change their value based on MQP defined by the Quality Department.

8.12 Brings Longevity in the use of Offline Measurement tool

With effective use of Metrological tool for sampling purpose only and let it breathe by not utilizing for the repetitive measurement task, we will increase the effective life of the Offline tool as well.

One can increase the profit earned from the product either by reducing the cost of material or by reducing the breakage/wastage of raw material as well as by mitigating the risk of rejection.

Current scenario

Following Table illustrates the idea of sampling frequency inculcated with Multi-crystalline and Mono-crystalline wafers at Diffusion Cluster.

Plant Running capacity	Wafer Type	No of sample per Shift	No of sample per Day	No of sample per Month	No of sample per Year	Samples Recoverable or not(Y/N)
100%	Multi	225	675	20250	243000	Y
	Mono	50	150	4500	54000	N
75%	Multi	169	506	15188	182250	Y
	Mono	38	113	3375	40500	N
50%	Multi	113	338	10125	121500	Y
	Mono	25	75	2250	27000	N

(All wafer counts are subjected to sample frequencies defined in MQP by Quality and performed by Production Department. Samples, taken by Process or Quality Dept. for Trial, Validation or Daily Quality Audit purpose are excluded from the count)

- All **Multicrystalline Sample Wafers** , after offline measurements, are recoverable and can be processed further after validating correct Junction orientation.
- These wafers are manually handled and can produce Electrical Rejection or hand touch can be reflected in EL images.
- **Monocrystalline Sample Wafers** are not recoverable as scratches are evident at the rear surface after measurement on the offline tool and Product like PERC is very susceptible to scratches on either side.
- There's always a chance of wafer breakage during Manual/Poor handling which will directly affects the production Yield.
- Sometimes we are facing issue with junction-less-non-diffused wafers processed through tester and cause High Electrical Rejection, just because offline tool can't differentiate between the Rsheet of Texture wafer and Diffused wafer especially when the resistivity of the wafer is high.

What If Non-Diffused wafer processed through Diffusion?

You cannot manufacture cell without P-N junction and with this, the entire operational and processing cost of the wafer (Chemical, Gases, Silver and AL paste) will go in vain.

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Cape of Good Hope

- The good news is, Inline Semi-Lab tool has the ability to differentiate between Texture and Diffused wafers irrespective their resistivity by depicting Empty value of Rsheet during measurement of texture wafers.
- **Non-diffuses wafers cannot escape from an eye of the Tool.** This ability of Tool, merge with the Algorithm of La Analitica offers the user to identify the chaff out of wheat.

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What La Analitica Brings to an Existing System?

- It gives health report of the process and provides continuous feedback to prevent deviation.
- We can reduce or eliminate the frequency of samples and by doing so, our breakage, rejection, and rework will go down and that brings fortune to an organization.

Estimated Cost saving

Plant Running Capacity	Wafer Type	Approx. Cost of Wafer	Sampling Frequency Reduced By	No of samples Saved per Day	No of Samples Saved per Month	No of Samples Saved per Year	Approx. Savings per Day	Approx. Savings per Month	Approx. Savings per Year
100%	Multi	₹ 20	50%	338	10125	121500	₹ 6,750	₹ 2,02,500	₹ 24,30,000
			75%	506	15188	182250	₹ 10,125	₹ 3,03,750	₹ 36,45,000
			100%	675	20250	243000	₹ 13,500	₹ 4,05,000	₹ 48,60,000
	Mono	₹ 30	50%	75	2250	27000	₹ 2,250	₹ 67,500	₹ 8,10,000
			75%	113	3375	40500	₹ 3,375	₹ 1,01,250	₹ 12,15,000
			100%	150	4500	54000	₹ 4,500	₹ 1,35,000	₹ 16,20,000
75%	Multi	₹ 20	50%	253	7594	91125	₹ 5,060	₹ 1,51,880	₹ 18,22,500
			75%	380	11391	136688	₹ 7,590	₹ 2,27,820	₹ 27,33,750
			100%	506	15188	182250	₹ 10,120	₹ 3,03,760	₹ 36,45,000
	Mono	₹ 30	50%	57	1688	20250	₹ 1,695	₹ 50,625	₹ 6,07,500
			75%	85	2531	30375	₹ 2,543	₹ 75,938	₹ 9,11,250
			100%	113	3375	40500	₹ 3,390	₹ 1,01,250	₹ 12,15,000
50%	Multi	₹ 20	50%	169	5063	60750	₹ 3,380	₹ 1,01,250	₹ 12,15,000
			75%	254	7594	91125	₹ 5,070	₹ 1,51,875	₹ 18,22,500
			100%	338	10125	121500	₹ 6,760	₹ 2,02,500	₹ 24,30,000
	Mono	₹ 30	50%	38	1125	13500	₹ 1,125	₹ 33,750	₹ 4,05,000
			75%	56	1688	20250	₹ 1,688	₹ 50,625	₹ 6,07,500
			100%	75	2250	27000	₹ 2,250	₹ 67,500	₹ 8,10,000

(All wafer counts are subjected to sample frequencies defined in MQP by Quality and performed by Production Department. Samples, taken by Process or Quality Dept. for Trial, Validation or Daily Quality Audit purpose are excluded from the count)

It is conspicuous from the data that how much our machines are spendthrift and how well can La Analitica be a good parent.

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Guidelines

- The user has to follow the Three Step Process given in User Manual to operate La Analitica (Please refer User Manual for better understanding)
- Analytics algorithm can process a defined number of data at a time hence connected prime file has to be changed after every 15 days to avoid overflow of a data point.
- Supportive File at Data Simulator will automatically change after the 15th day of every month. The user has to ensure the whereabouts of the file is proper or not.
- Select proper Prime and Supportive file of the same machine to avoid any data mismatch.

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Limitations

- The functionality of La Analitica is strictly adhering to guidelines given to the user; any deviation will cause malfunctioning of the system.
- La Analitica collects data from the common server hence, its functioning and refresh rate entirely depends on connectivity and network strength.
- La Analitica is designed to process definite data fetched from Prime file to avoid any data size complication and can speed up the task.

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System compatibility

- La Analitica is compatible with excel version beyond 2007(64bit)
- Operating System of PC should be Windows 7 (2009) - MS Version 6.1 and beyond with 64bit OS type.

- A user has to enable the macro setting described below.

- (1) **Open** an Excel File
- (2) Click on **File button** (Top Right corner)
- (3) Go to **Options**
- (4) Click on **Customize Ribbon** and apply **check mark on Developer option**
- (5) Go to **Trust Center setting** given below Customized Ribbon button
- (6) Open **Trust Center Setting --> Macro Setting --> Click Enable All Macros**

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Pre Requisite

- The authenticity of data is entirely depending upon the Calibration of Inline Rsheet measurement.
- Macro Enabled Excel version is required at Diffusion machine to use Supportive File Generator
- The frequency of calibration has to decide by production, process and quality department.

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Closure

- La Analitica brings the entirely new direction to Diffusion cluster and its implementation will transform the existing sluggish and inactive system to smart and active system.
- La Analitica will evolve as the time flies with valuable feedbacks of the users.

Thank You