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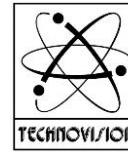
Resist Removal on Photo Mask Cleaning

(For LED Production)

Presented by Ted Miyagawa
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Introduction: Mask Cleaning

- LED Production has been increasing in years
 - Photolithography process are now in full operation
 - Photo Mask Quality becomes more important ever
 - Mask cleaning quality and its throughput are Keys in High yields
- This paper discuss about How and Why Mask becomes dirty, and also discuss which cleaning process is most efficient

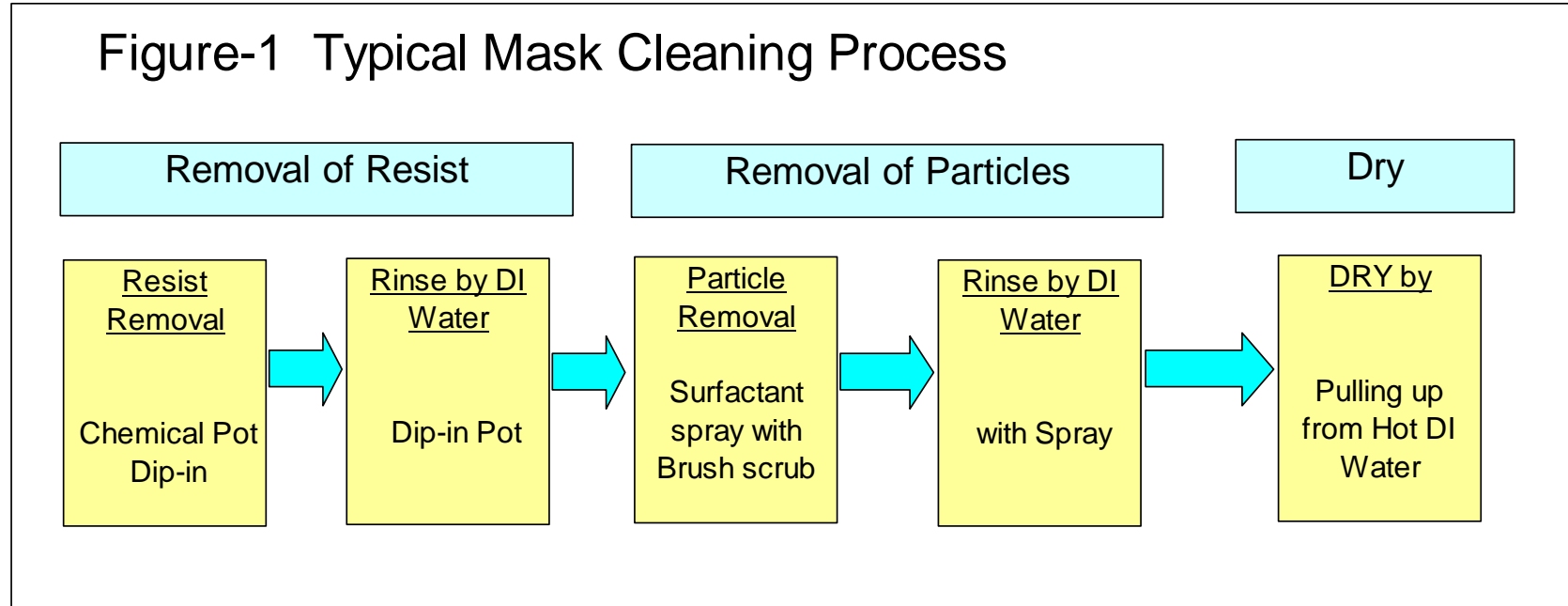
1) Typical Mask cleaning steps: It consist of 5 steps as:

- Step1 Resist Removal
- Step2 Rinse by DI (deionizer) Water
- Step3 Spray Surfactant with Brush scrubbing
- Step4 Spray rinse by DI Water
- Step5 Dry by pulling up from Hot DI Water

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Figure-1 Typical Mask Cleaning Process



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2-1) What kind of Dirt (Resists) are there and Why

- Mask may touch Wafer surface by contact aligner, then, copies resists.
- 25 or 50 times of UV exposures after Mask get copied resist, more sticking

2-2) What chemicals are used for Resist Removal

- Ex-1) Organic Solvent (ACETONE, ETHANOL)
- Ex-2) Developer or Remover for resist are used as Cleaning Chemical
- Ex-3) RCA Cleaning method such as, H₂SO₄ Hot Sulfuric acid
- Ex-4) Alkaline amine Chemical is under evaluation by us

2-3) How effective are Ex-1 to Ex-4 in Cleaning

-- See Comparison Table -1

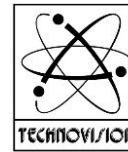
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Table-1 Cleaning Performance Guide

Remove Resist	Organic solvent		Alkaline Cleaner by Technovision		RCA Method	Developer/Remover	
	Acetone	Ethanol	TRC-1310	TRC-170	SC1 (APM)+SC2(HPM)	TMAH	Stripper
Mask with proximity Exposure	○	△	◎	◎	◎	○	◎
Mask with contact exposure	○	△	◎	◎	◎	△	◎
Mask with more than 100 times exposures	△	×	◎	○	◎	△	○
Mask with after two month of exposure	×	×	◎	△	◎	×	△

◎	Excellent performance
○	Good
△	sometime Good,
×	No hope

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2-3) How effective are EX-1 to EX-4

•Ex-1) Organic Solvent (ACETONE, ETHANOL)

Most frequently used, and easy to obtain with low price, But, Flammable and hazardous
Cleaning performance is LOW.

•Ex-2) Developer or Remover for resist

- Effective under limited condition, Hazardous that not recommendable to use at FUME FOOD.
Better than Ex-1, but still not good enough, like after 100 times UV flash, EX-2 may be not satisfactory

•Ex-3) RCA Cleaning method such as, H2SO4 Hot Sulfuric acid

- Most powerful chemicals that can clean any resist, but experienced engineer is required for handling. It may etch Chrome pattern.

•Ex-4) Alkaline amine Chemical is under evaluation by us







- Mask cleaning Evaluations has been in progress, its performance seems much better than, EX-1, and EX2. As for New cleaning Alkaline Chemical performance is high as EX-3

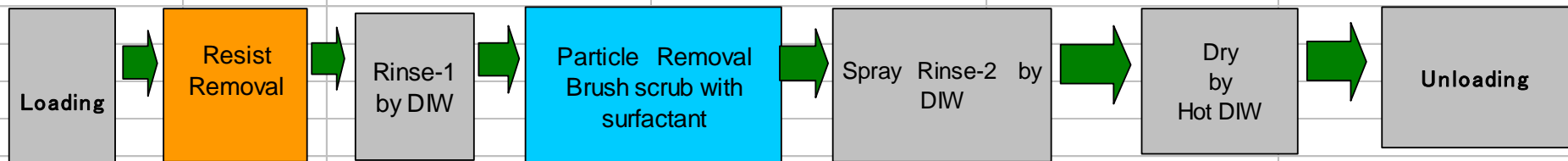
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Table-2 CHEMICAL USE

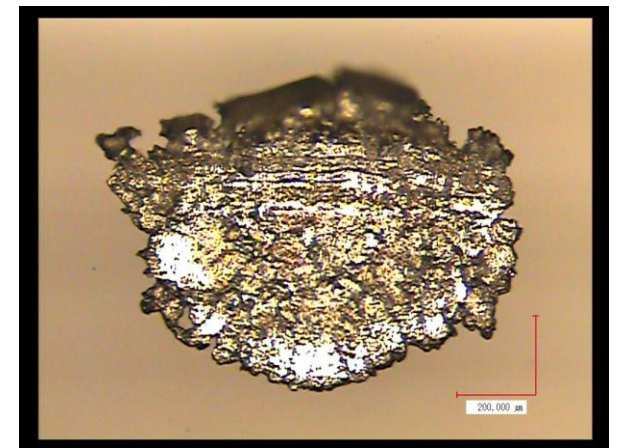
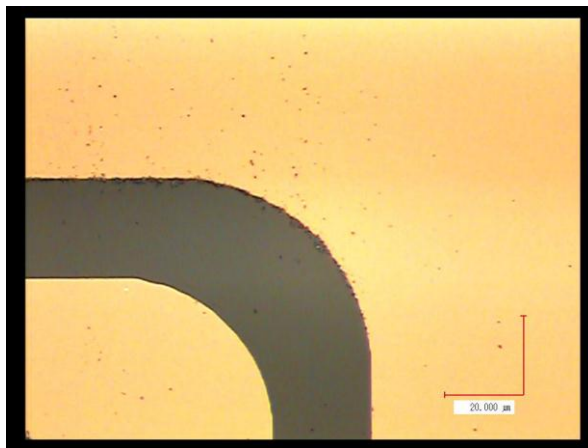
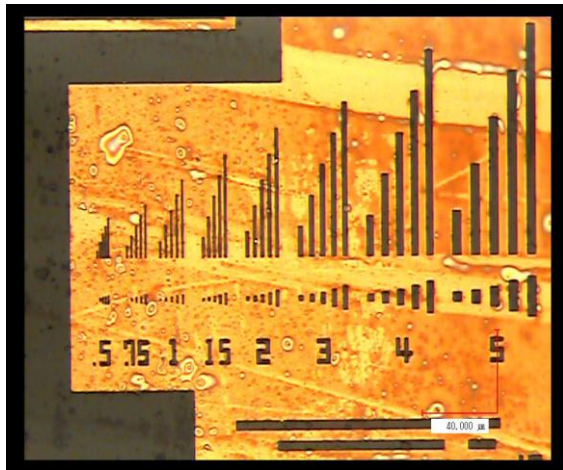
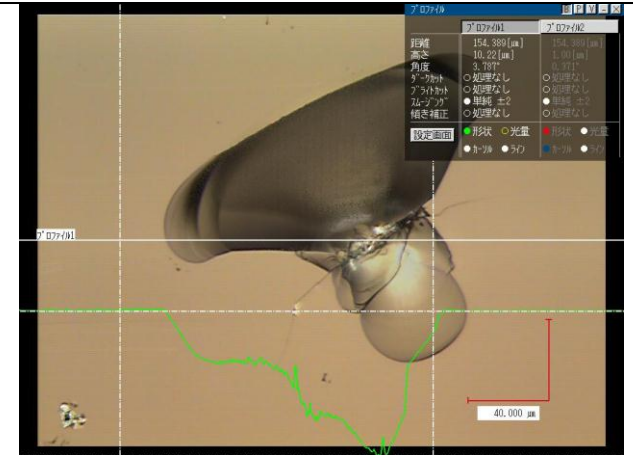
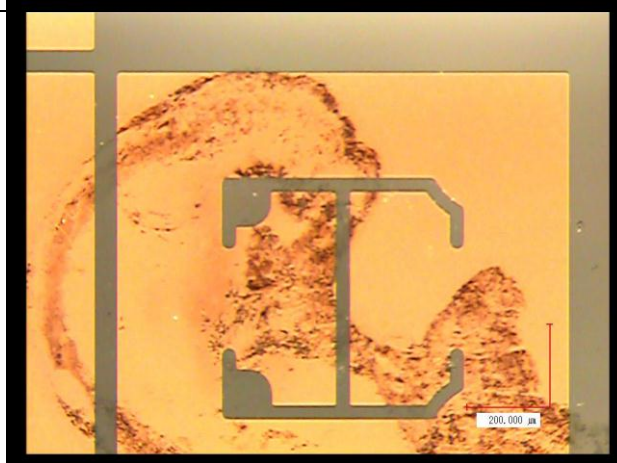
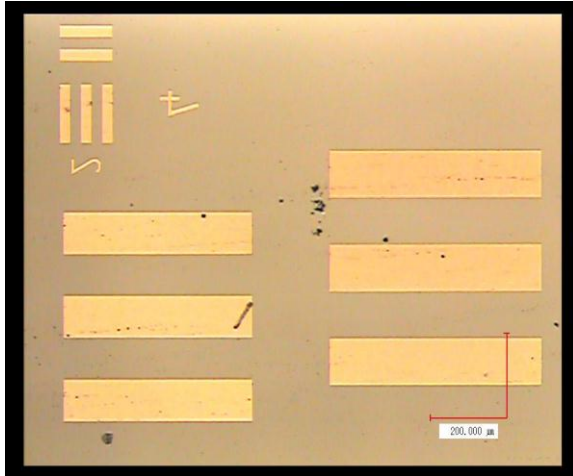
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		Resist Removal	Resist Removal	Particle Removal	Particle Removal
		(For Resist)	(For Resist)	(For Particles)	(For Particles)
		TRC-1310	TRC-170	TRC-123	TRC-151
Specifications	PH (1%)	12.5	12	12.5	Neutral
		Inorganic Alkaline	Organic Alkaline	Inorganic Alkali Surfactant	Neutral Surfactant
Uses	Dilution	As formulated (0%)	10~30%	1~5%	5% (Normal Use) 10~50% (Powerful Use)
	Temp.	50~70°C	RT~50°C	RT~40°C	RT~50°C
Regulations	Flammable	N/A	N/A	N/A	N/A
	GHS	 	 	 	N/A
	PRTR	Applicable	N/A	N/A	N/A



Pic-1
Sample of Dirty masks

S1: Resist, S2: watermarks S3: broken glass
S4: with dropped resist S5: Subliminal contamination S6: In ball



What type of Mask cleaner and USE

USHIO Lighting—Edge Technologies

Mask Aligner

プロキシミティ/コンタクト露光装置
Proximity/Contact Exposure System

UX-3 series



1. 優れたコストパフォーマンスで高解像力を達成

Achieve High-resolution and Good cost performance.

■ 露光モード別解像力

プロキシミティ Gap=20 μm	3 μm L/S
ハードコンタクト Gap=0 μm+バックブロー	1 μm L/S
バキュームコンタクト Gap=0 μm+バックブロー+真空引き	1 μm L/S 以下

※ボジ型液状レジスト1 μmt

■ 高い線幅安定性を実現

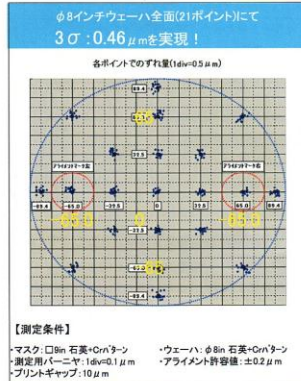
プロキシミティ Gap=20 μm	±0.22 μm
ハードコンタクト Gap=0 μm+バックブロー	±0.19 μm
バキュームコンタクト Gap=0 μm+バックブロー+真空引き	±0.15 μm

※ボジ型液状レジスト1 μmt
6 μm L/S、ウエーハ面内20点を測定

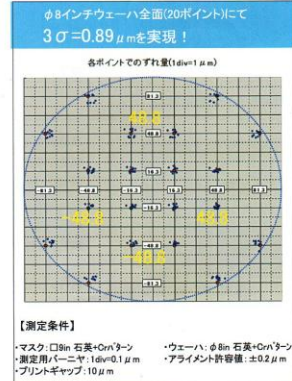
2. 高精度重ね合わせを実現

High-precision overlay accuracy

■ 表面重ね合わせ



■ 表面重ね合わせ



Contact Aligner
(Proximity / Contact Aligner)

Chromium Mask
3 um Line/Space

Exposure ;	(Resolution)
Proximity 20 um	(3 um)
Hard contact	(1 um)

- * Compound Semicon (LD,LED,MMC,Power Device)
- * 3D Jisso、WLPKG
- * MEMS

Green Lighting Shanghai Expo and Forum 2012

•3) Evaluation of Alkaline Chemical

- Table-2 shown the USE of Alkaline base cleaner
- Samples dirty masks cleaned satisfactorily. (Pic-1)
- See also, Before and After Cleaning (Pic-2)

•4) Conclusions

•Current problem

- Resist Removal by Manual
- Chemical selection is not satisfactory
- Safety and hazardous becomes key issue
- Throughput of Mask Cleaning

•Solution

- Alkaline Chemical for resist removal is data proof
- Safety handling is considered , at equipment design
- Proper recipe can optimize process to better throughput
- Data proof Alkaline chemical are selected

•Acknowledgment

- The author would like to thank Mr. H. Hori, H. Enomoto, K. Sahara, from PARKER CORPORATION as most of the tests and evaluation have been conducted at their R&D Lab. under their help and guide.

Thank you (END)

Mask-Cleaner for LED production



TWC-200A Mask Cleaner
For LED Production