ASAHI GLASS COMPANY

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Development of low defect glass substrates for EUVL

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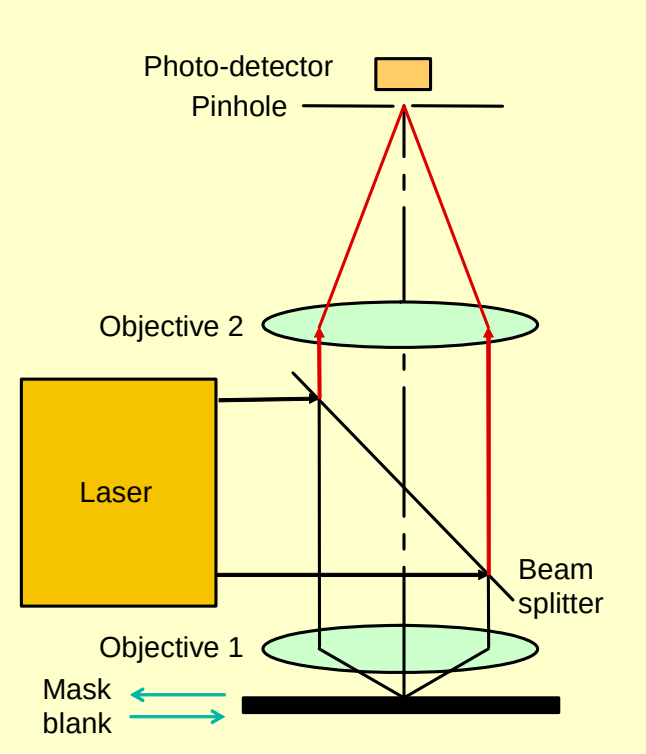
Outline

- Defect inspection system and sensitivity
- Champion defect density
- Defect reduction
  1. Particles – cleaning technology
  2. Pits – polishing technology
- Concave defect mitigation
- Summary

Defect inspection system M1350

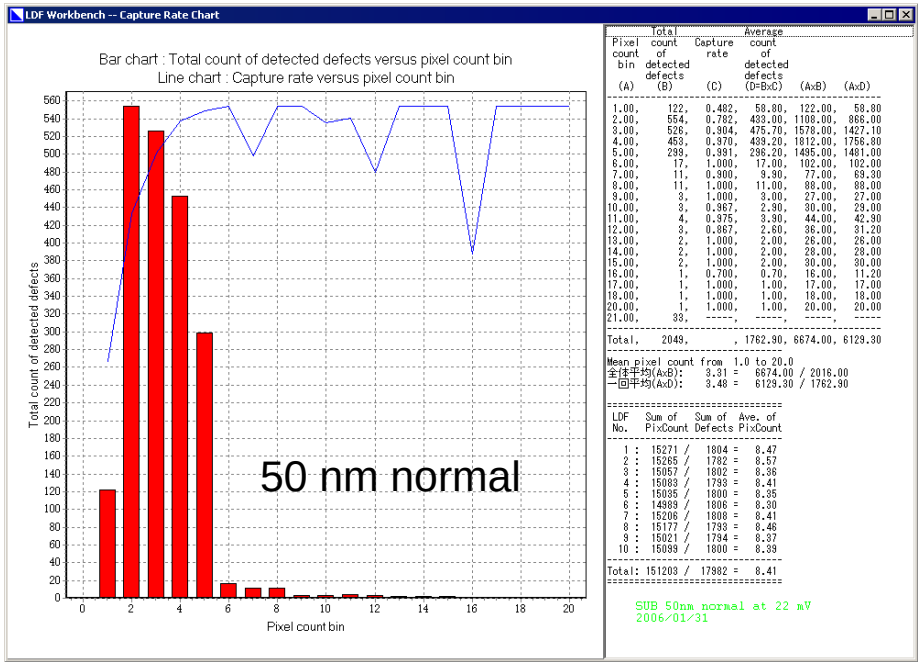


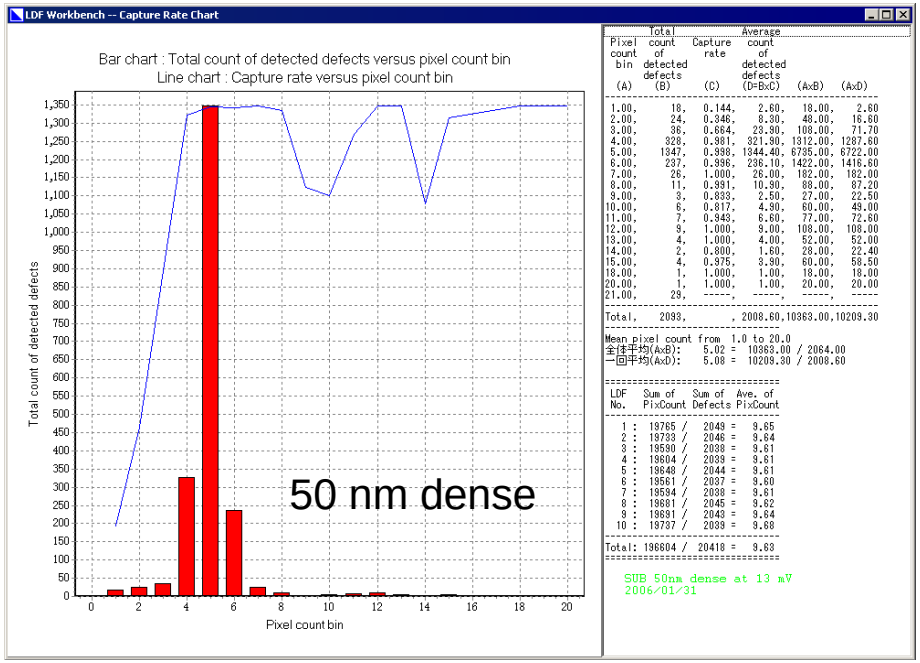
- AGC has installed a Lasertec 488 nm laser defect inspection system.

Sensitivity of PSL on substrate

- 60nm PSL is detected at a pixel count of 6.5 with a capture rate of 100%.

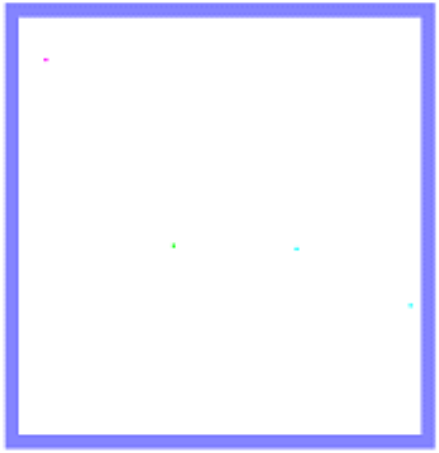
SUB	60 nm		50 nm	
	normal	dense	normal	dense
Mean pix count	6.51	6.52	3.31	5.02
Capture rate	1	1	0.904	0.998
@ pixcel	6	6	3	5



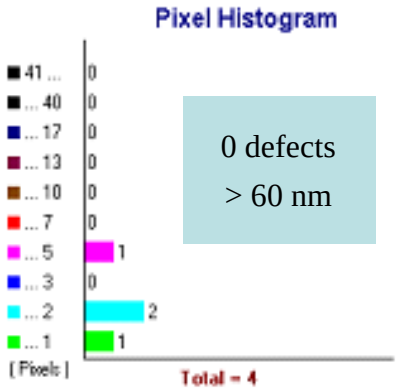


Champion defect results of substrates

Quartz (AQ)



LTEM (AZ)



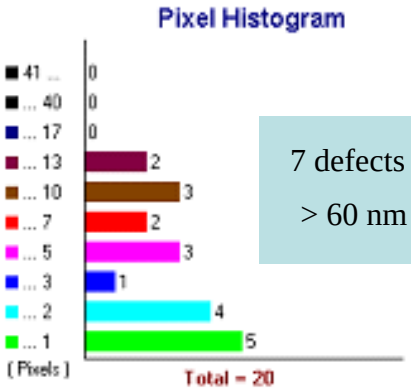
0 defects
> 60 nm

PSL equivalent size

11 pix : 82 nm

6 pix : 60 nm

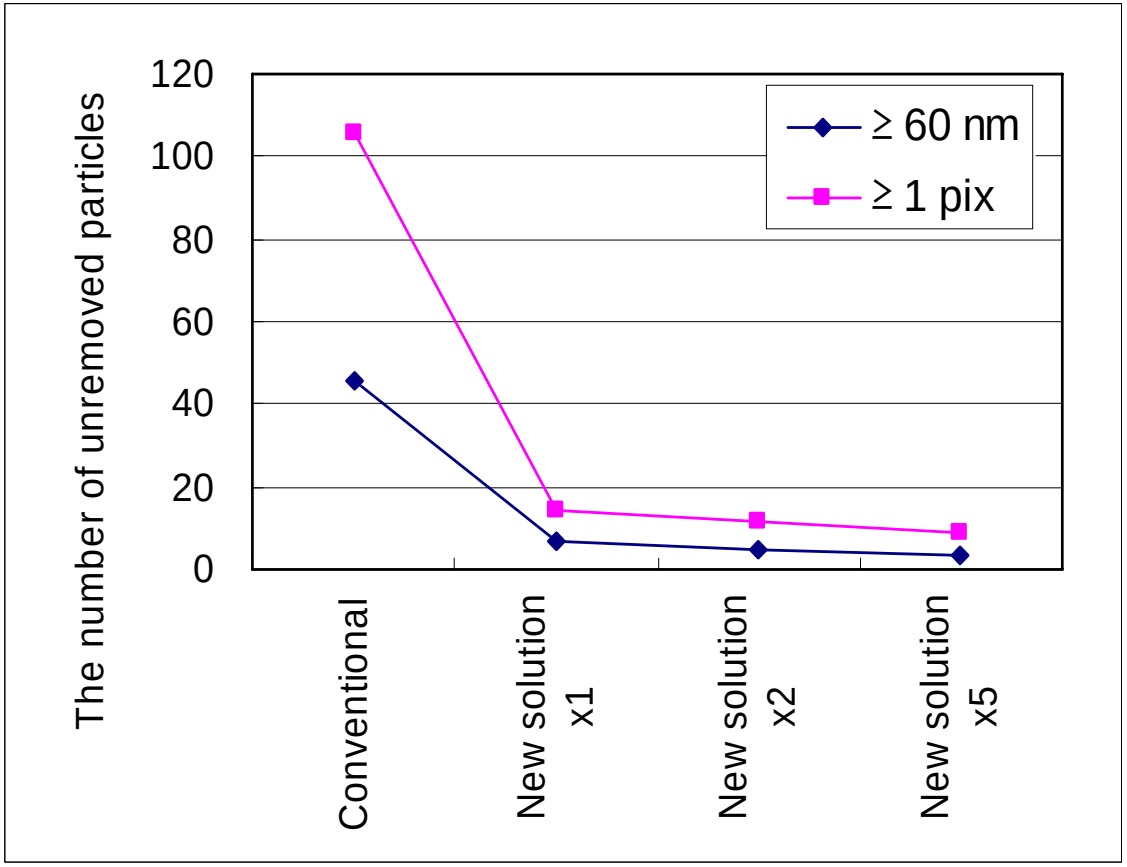
Capture rate < 100%



7 defects
> 60 nm

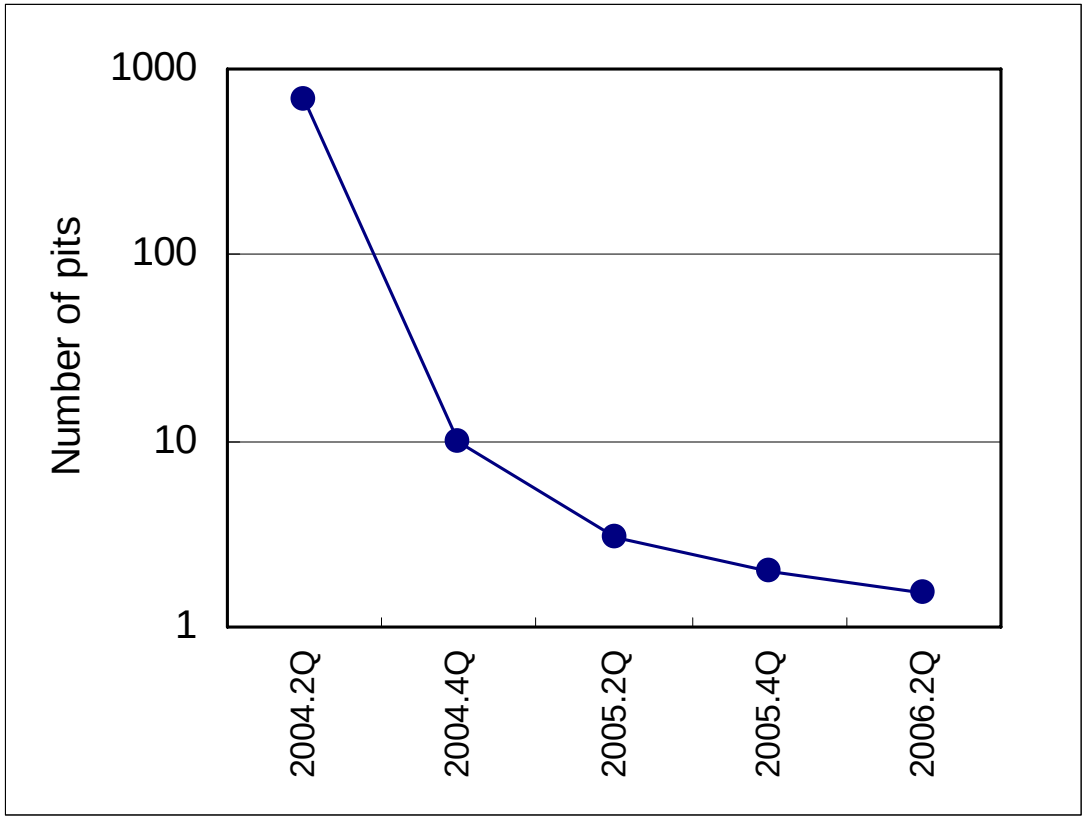
- Defects on AZ substrate are more difficult to reduce than those on quartz.

Defect reduction in particles – cleaning process



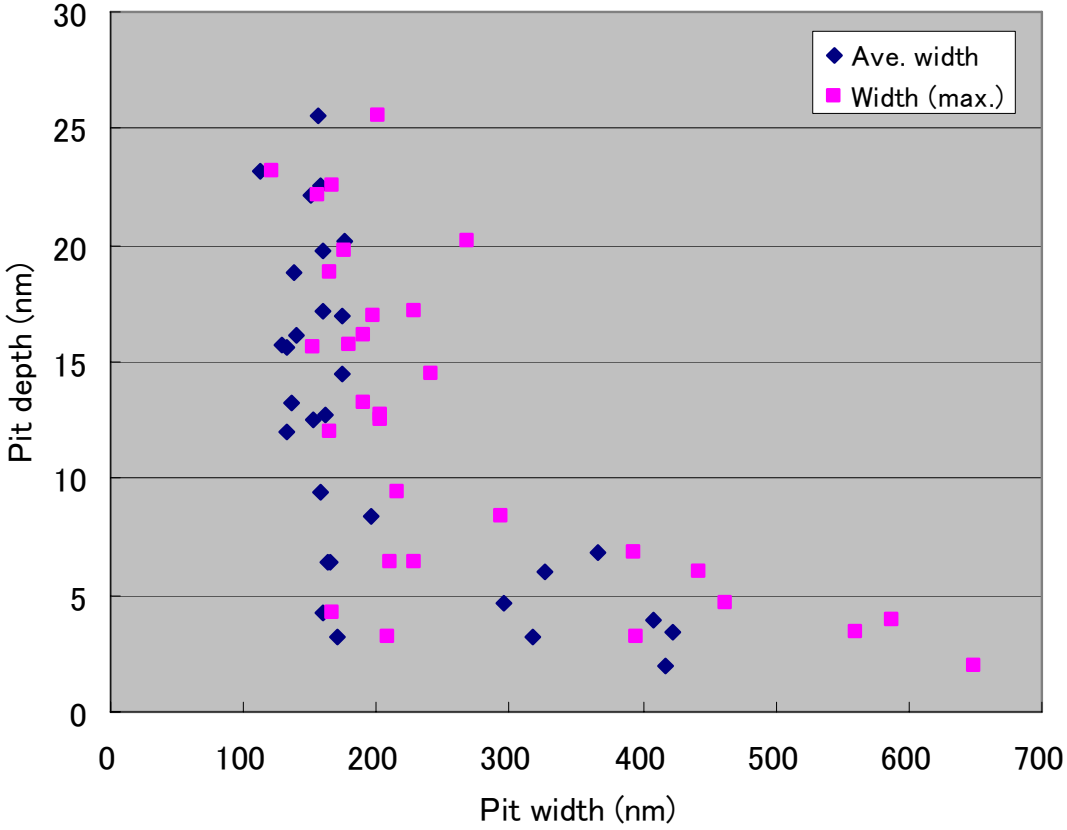
- New solution has a higher removal ratio, especially for smaller particles.

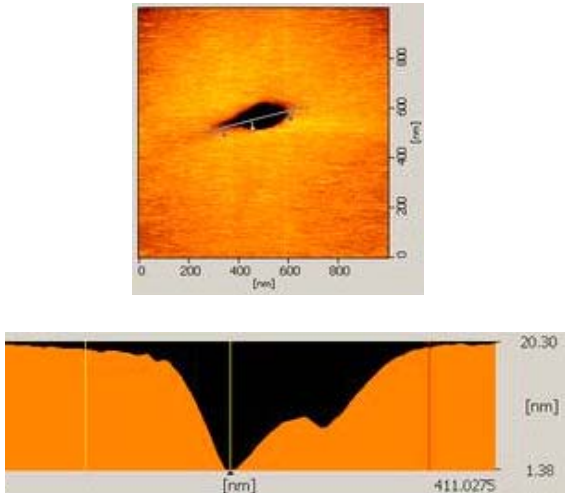
Defect reduction in pits – polishing process



- Pits have been reduced by modifying the polishing process.
- The inspection system is no longer sensitive enough for detection of <u>pits on substrate</u>.

Detectable pit size on substrates by M1350



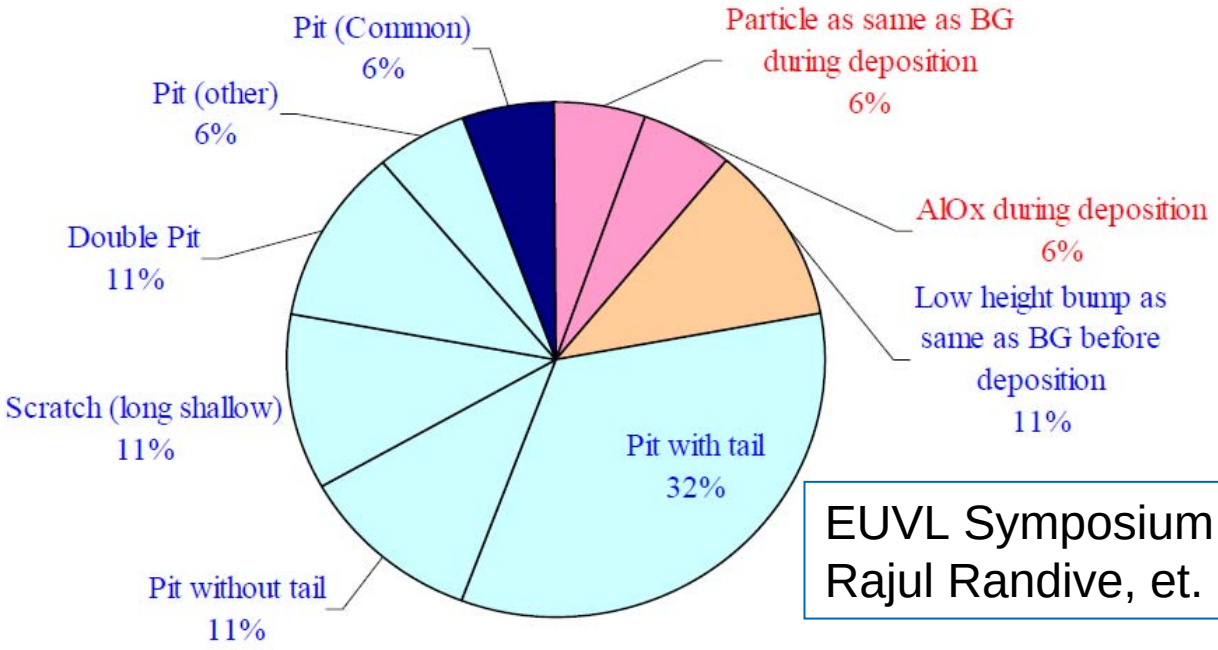


AFM image of a pit.

- These pits on substrates are detectable by M1350.
- We have succeeded in the reduction of detectable pits on substrates.

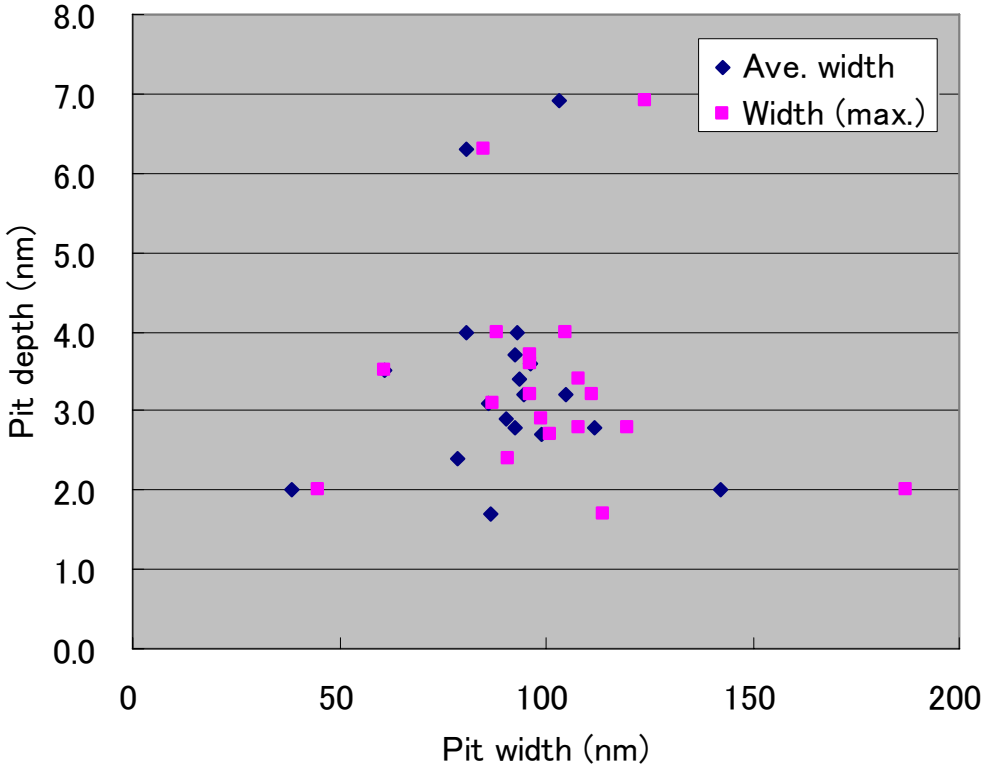
Total defects on 1st ML

- After ML deposition, pits and scratches become the dominant defects that originate from a substrate (78% of the total defects on 1st ML).
- These concave defects are not detectable for substrate inspection.
- As a substrate supplier, AGC has concentrated on concave defect reduction by modifying the polishing process.



EUVL Symposium Nov. 8, 2005
Rajul Randive, et. al.

Sensitivity improvement for pits



- After deposition of a high reflectance film such as ML, the detectability of pits that originate from a substrate is highly improved. (“Decoration effect”)
- Our new pit reduction target size was estimated and the pit printability should be studied further.

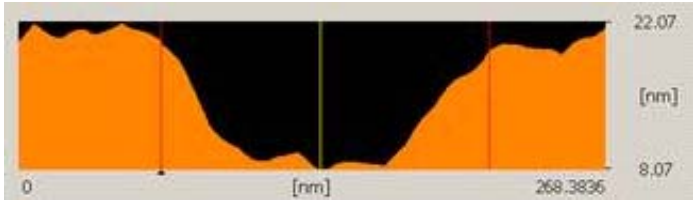
Concave defect mitigation

- Feasible study -1

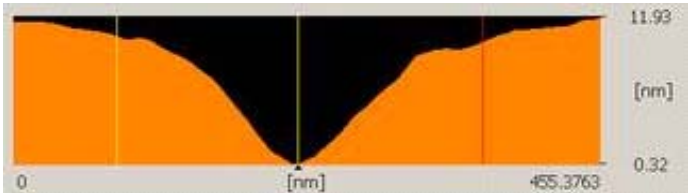
Pre planarization (nm)			Post planarization (nm)		
Width (Min)	Width (Max)	Depth	Width (Min)	Width (Max)	Depth
102	229	6.4	Totally covered		
98	294	8.4			
100	203	12.5			
108	242	14.5			
83	268	20.2			
145	156	22.1			

- Feasible study -2

Pre planarization (nm)			Post planarization (nm)		
Width (Min)	Width (Max)	Depth	Width (Min)	Width (Max)	Depth
130	463	4.7	176	363	3.2
211	443	6.0	190	390	5.2
99	165	12.0	150	284	10.0
113	153	15.6	155	234	8.9
89	190	16.1	138	296	7.2
91	228	17.2	170	267	8.4



Planarization



- Concave defects can be mitigated by some planarization methods.

Summary

- AGC has been developing low defect glass substrates for EUVL and has established the infrastructure required for small scale production of EUVL mask blanks.

  LTEM material : poster presentation 05-MA-63

  EUV mask blank : oral presentation (Oct.17 - mask 2 session)

- Defect reduction in particles and pits has been achieved by modifying the cleaning and polishing technologies.

- Some concave defect mitigation feasible studies have been undertaken.