Development of zero expansion silica glass for EUVL substrate

Asahi Glass Co., Ltd.

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Outline

- *Implementation Schedule*
- *Material*
  - Preparing Ti-doped silica glass
  - Homogeneity of Ti-doped glass
  - Technique for precise adjustment of CTE
- *Surface finishing and metrology*
  - New flatness measurement tool
  - Improvement of flatness
  - Development of cleaning technology

Implementation Schedule

Year		2003	2004	2005	2006
CTE(ppb)	Mean	+/- 30	+/- 15	+/- 5	+/- 5
	Spatial	+/- 10	+/- 6	+/- 6	+/- 6
Flatness PV (nm)		150	100	50	50
HSFR rms (nm)		0.15	0.15	0.15	0.15
Defect (/cm2)		0.3 @150nm	0.05 @60nm	0.01 @60nm	<0.01 @60nm
Implementation Schedule		Experiment			Volume Production
			Pilot Production		

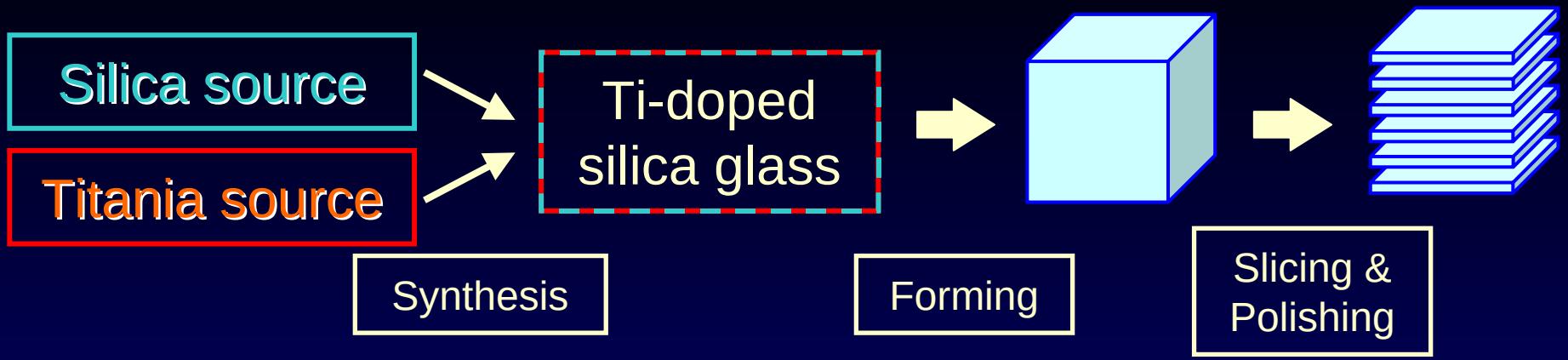
Preparing Ti-doped silica glass

- **Ti-doped silica glass can be producible by the method which is similar to "*Asahi silica glass producing method*".**

Highly homogeneous
Mass-producible

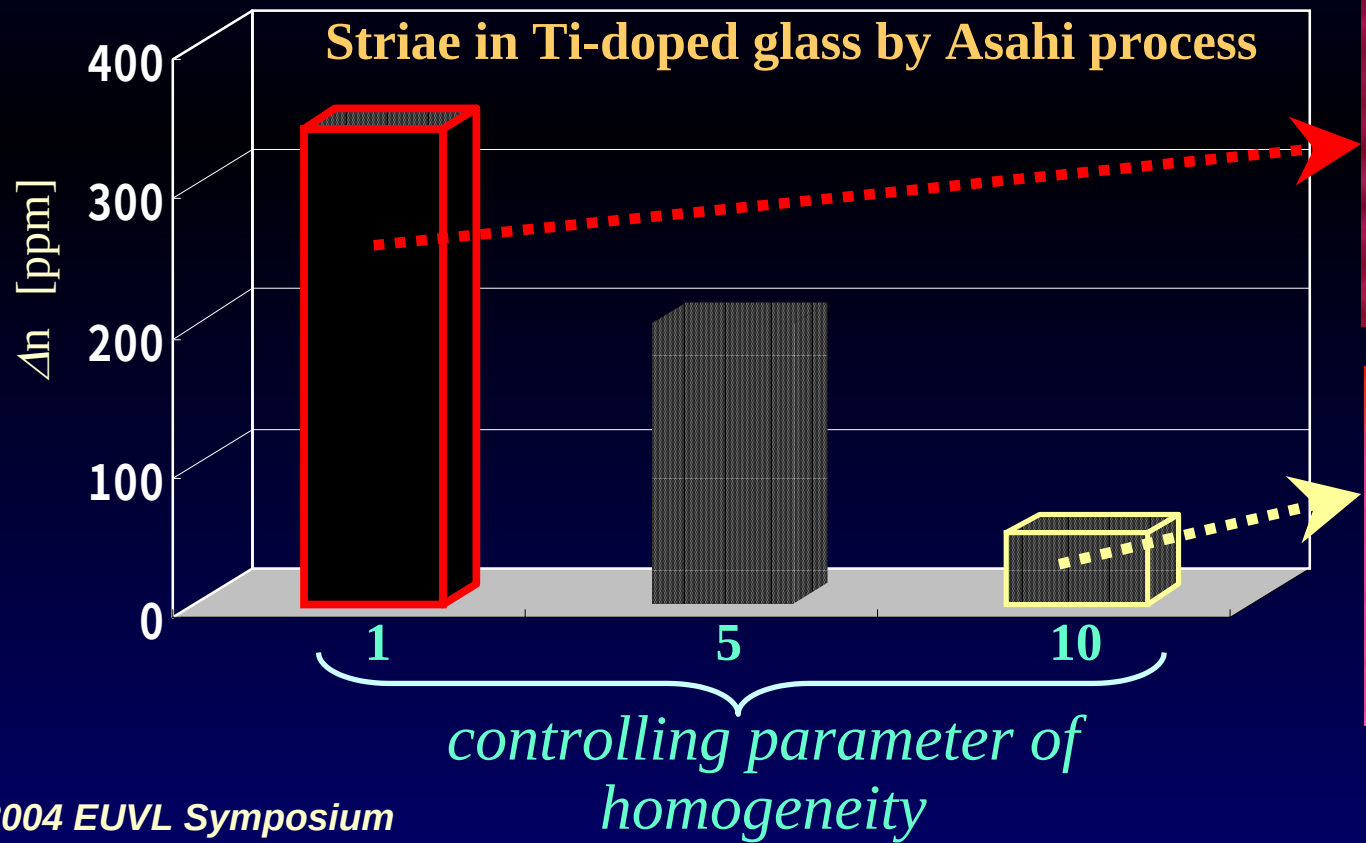
} **fused silica glass, AGC has been commercializing since 1985.**

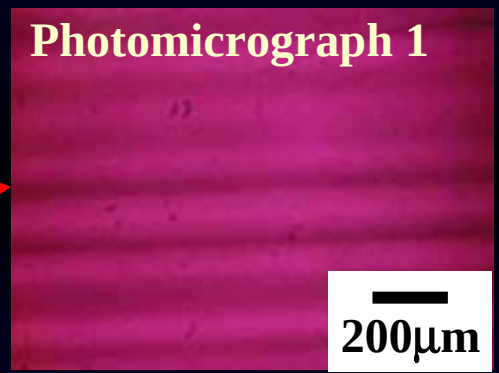
In the case of Ti-doped silica glass



Homogeneity of Ti-doped glass

- In *Asahi process*, the homogeneity of Ti-doped silica glass could be controlled.
- Striae can be hardly observed in *AGC Ti-doped silica glass* (Photo. 2) at the *controlling parameter* of 10.





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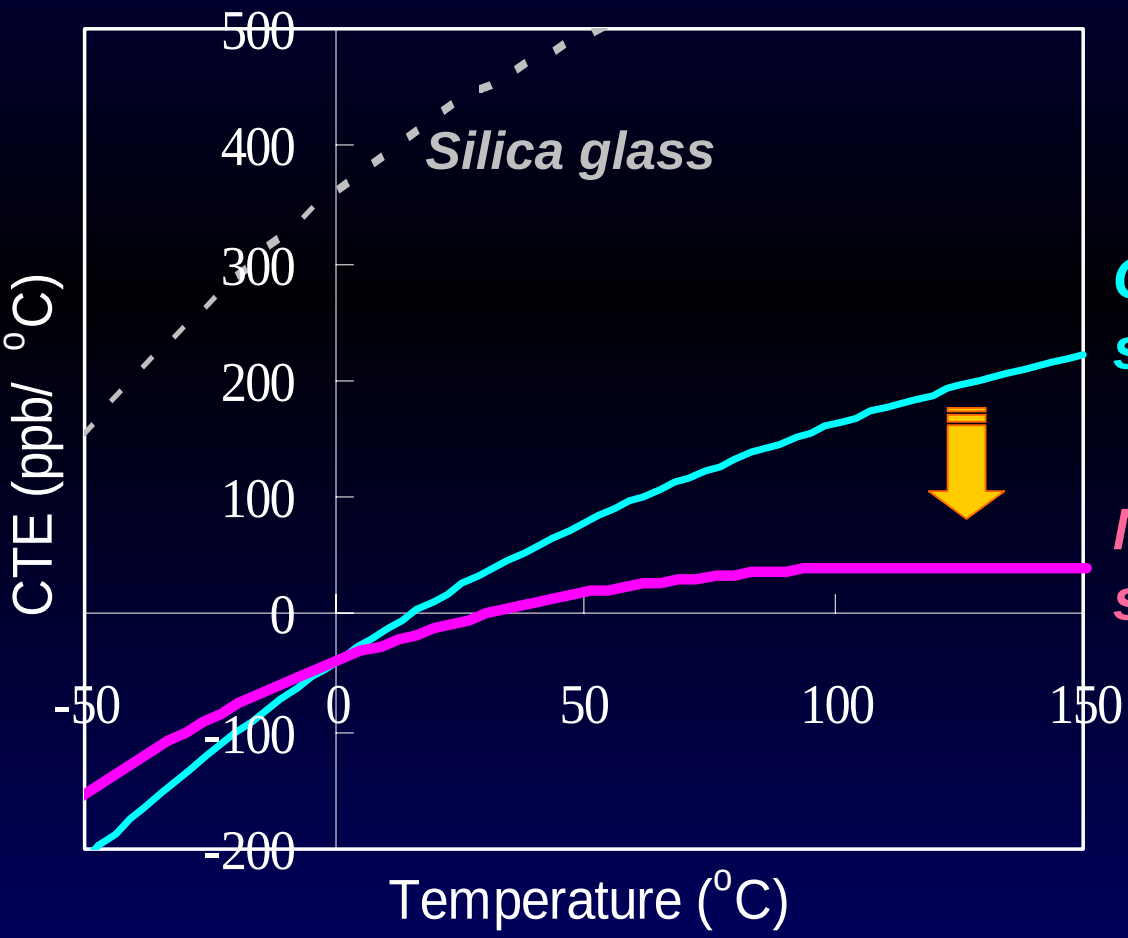
Technique for precise adjustment of CTE

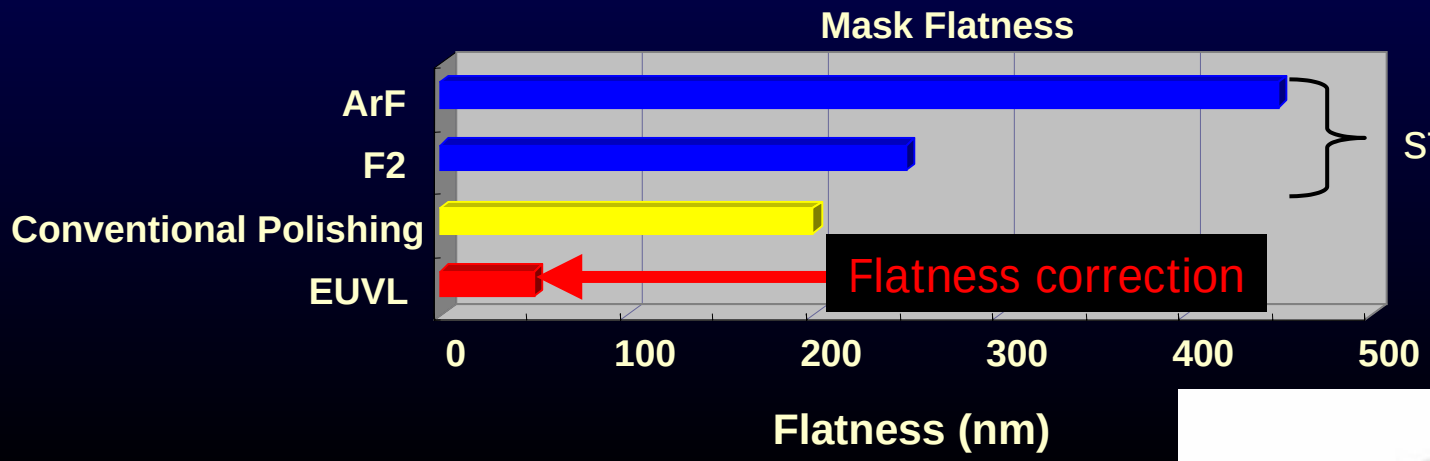
- **Optimization of *controlling parameter of CTE* will enable to expand low CTE region.**



Conventional Ti-doped silica glass

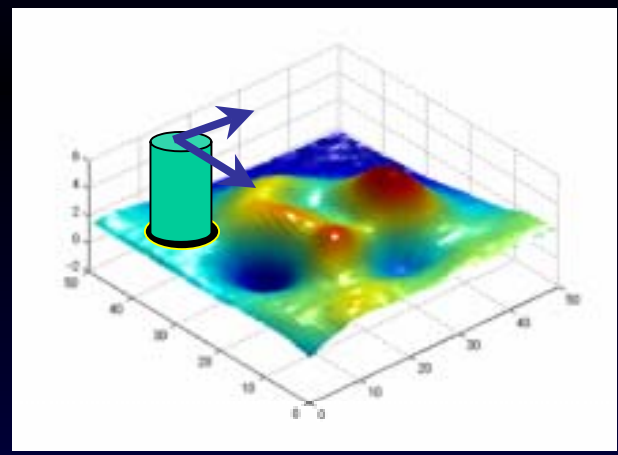
Newly developed Ti-doped silica glass by AGC

Concept of surface finishing process



Flatness correction method

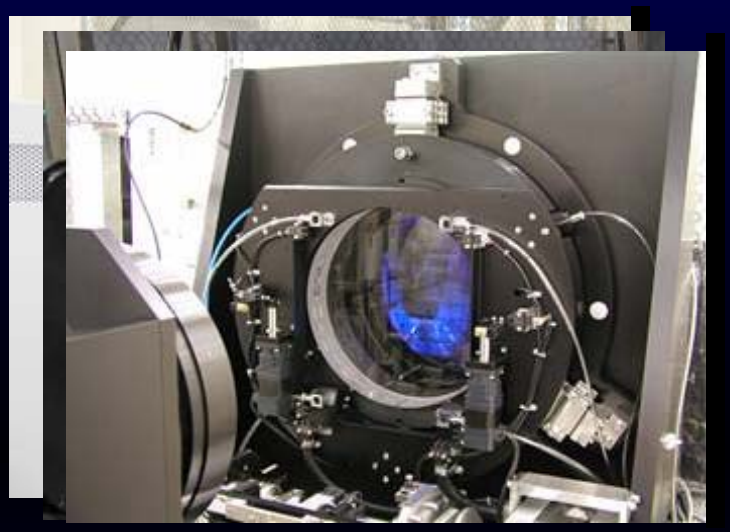
Scanning the small tool with controlling the removal which is based on the height data map

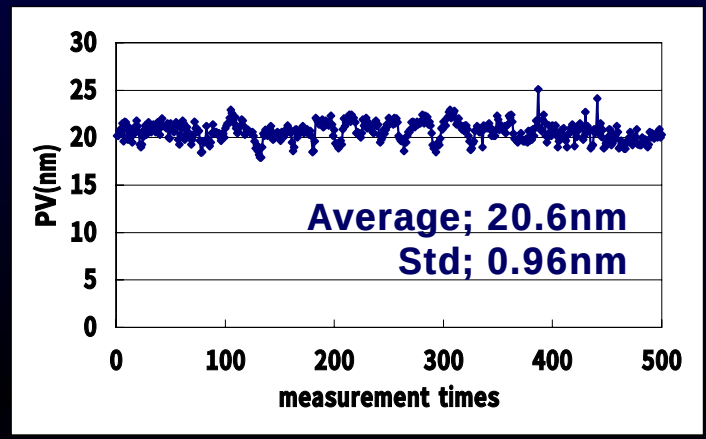


- Under50nm PV flatness can be made with the combination of good finishing machine and the high accurate flatness measurement system.

Flatness metrology

New fizeau interferometer has been developed with Fujinon





Features

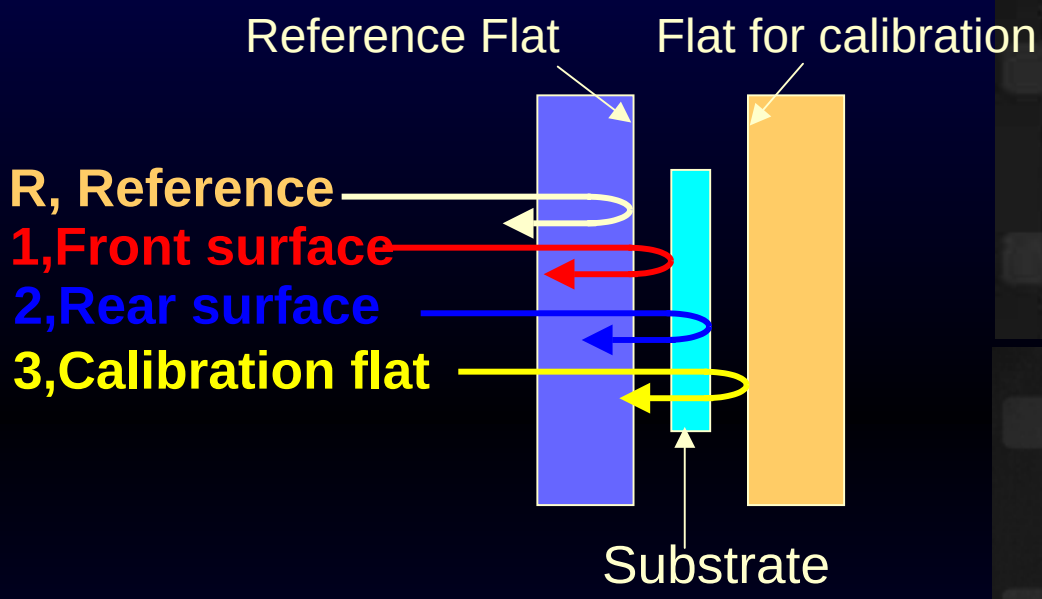
- Full automated substrate handling system achieved Class 1 environment
- The distortion of substrate by new holding system is extremely low and it can realize the true free standing form measurement
- Fujinon's unique method for thickness variation measurement is also available

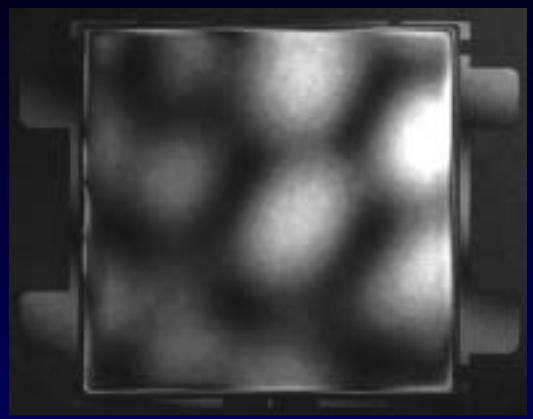
PV flatness of calibration flat
152x152mm area
1min interval
Total 500 times=over 8hours

- Good repeatability and high accurate measurement

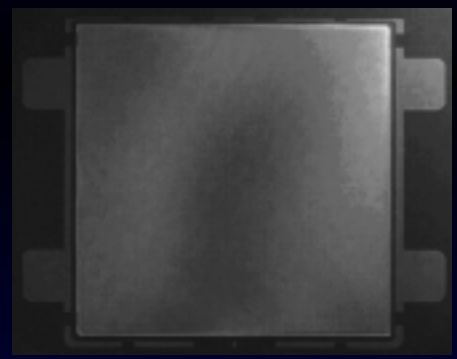
Multiple surface interference

- High Coherence mode
- Low Coherence mode

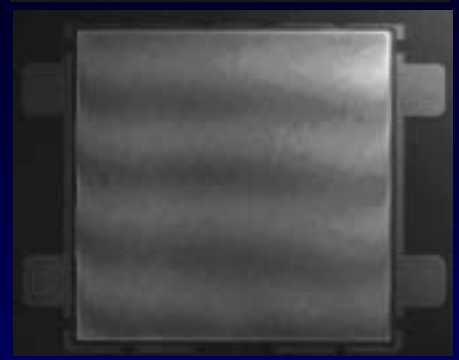




Front surface & Reference flat (R&1)



2.Rear surface & Reference flat (R&2)

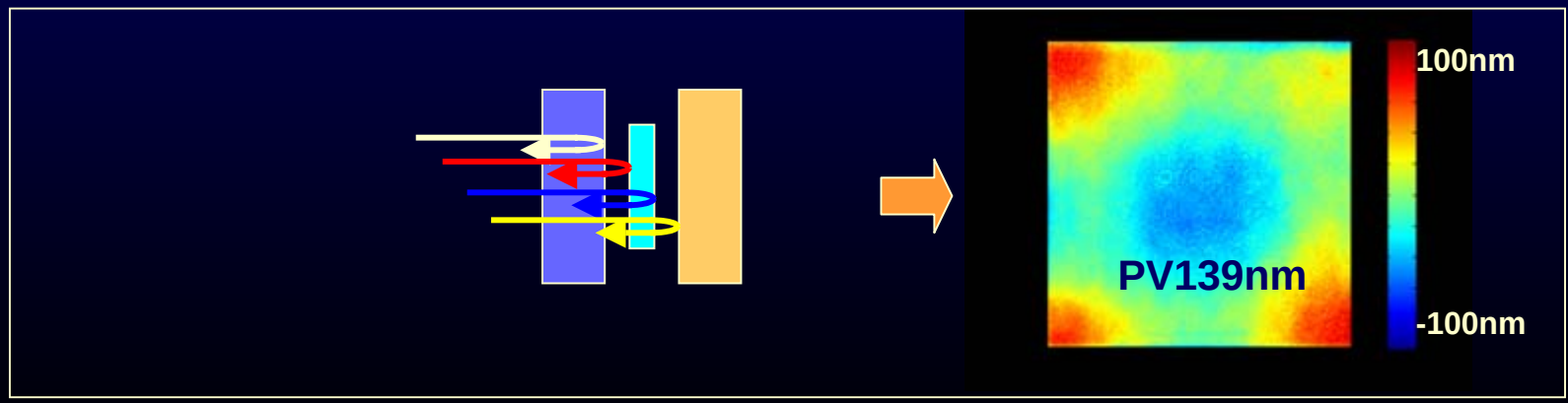


3.Calibration flat surface & Reference flat (R&3)

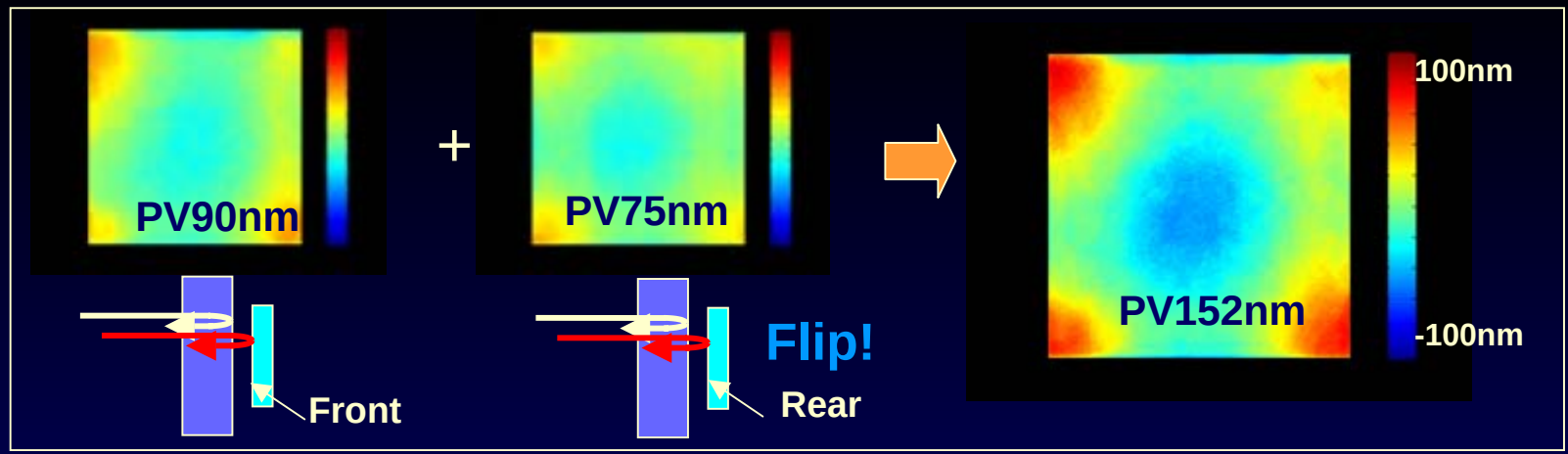
Thickness variation measurement

Fused Silica Glass substrate, 142X142mm area

- Calculation from multiple interference measurement (Tilt removed)



- Calculated from Free Standing Form (Front +Rear - Wedge)



The results by two different method are very close
That means the distortion by clamping is less than 10nm

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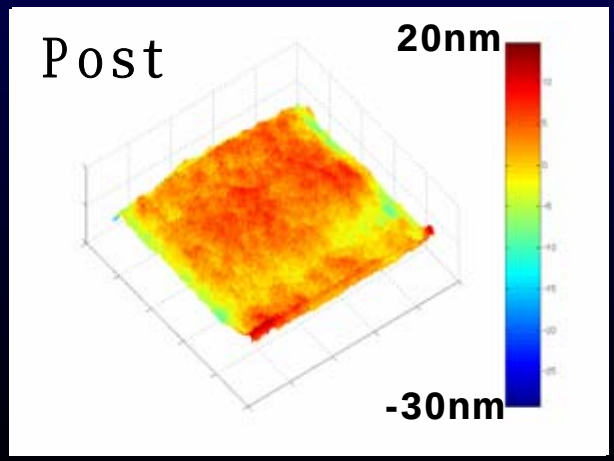
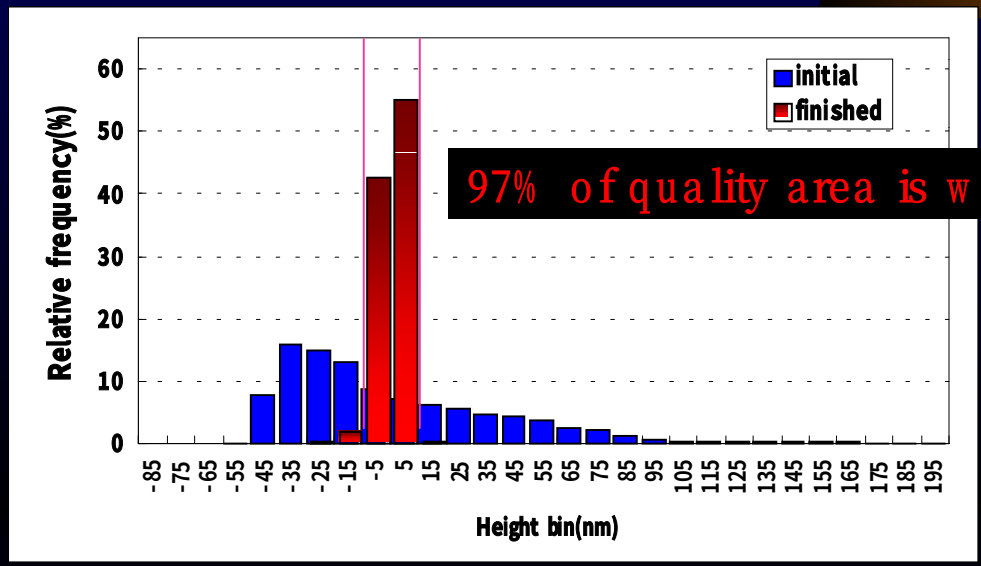
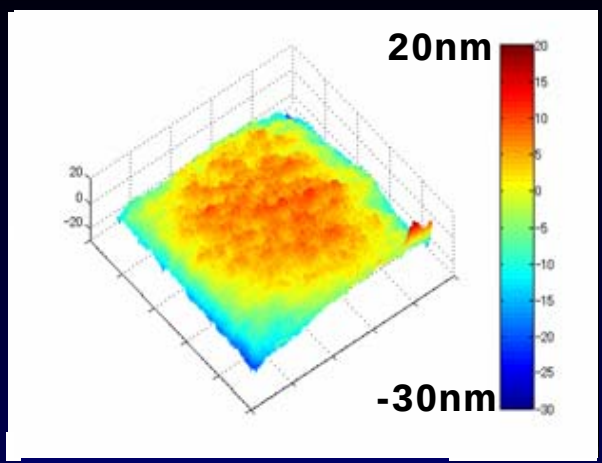
Flatness Improvement



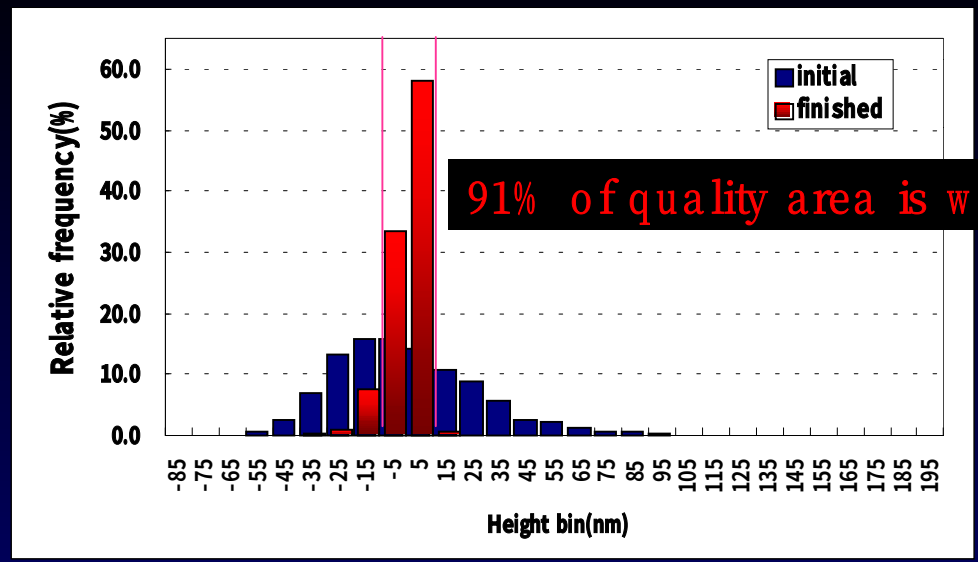
Flatness: PV45nm



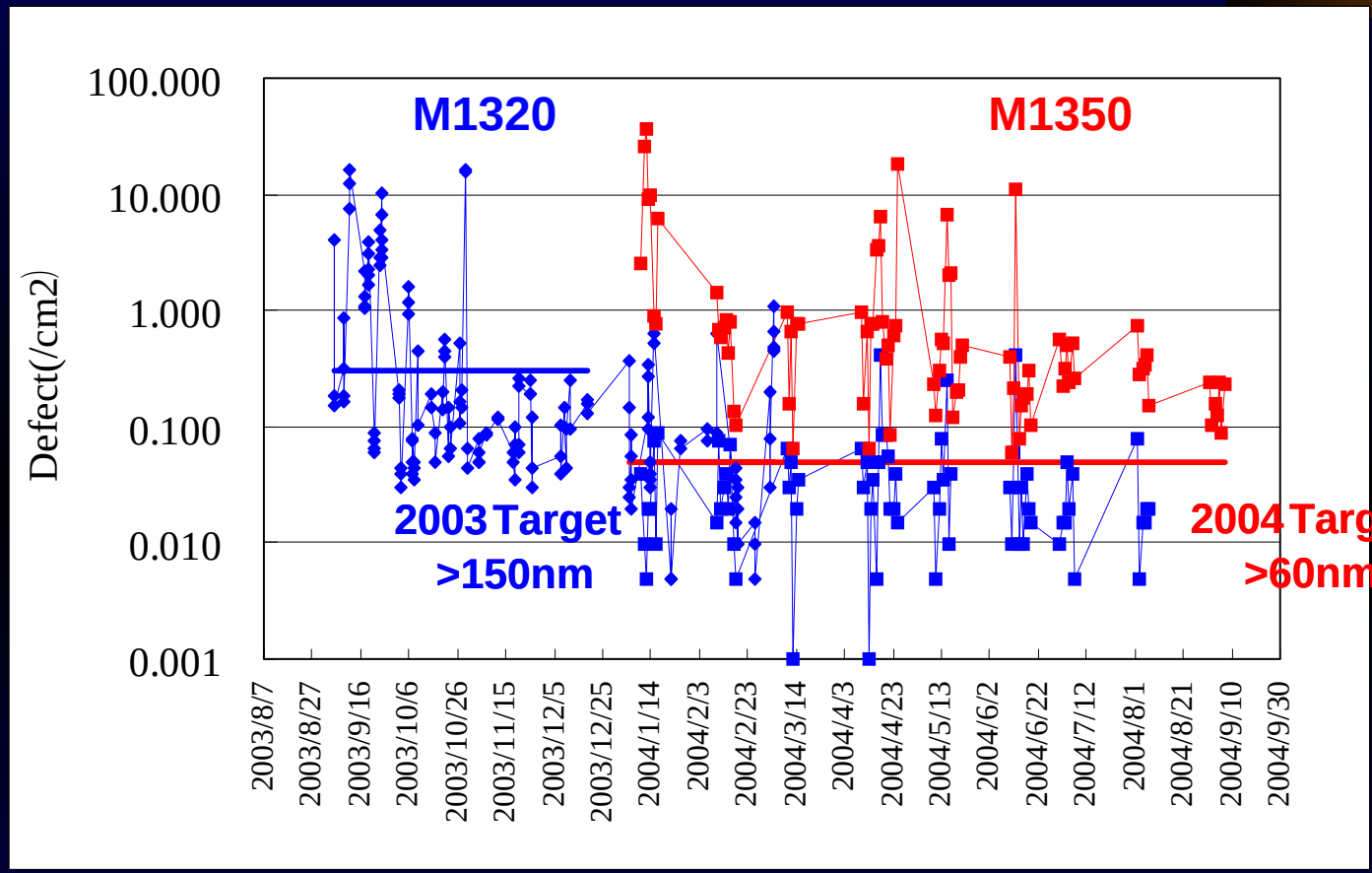


Flatness: PV55nm

142*142mm area



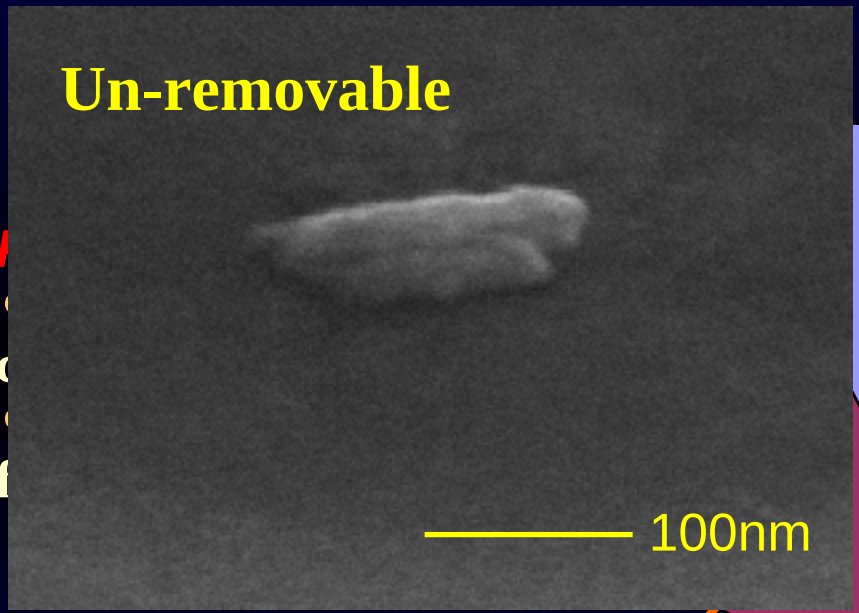
The Result of Substrate Cleaning

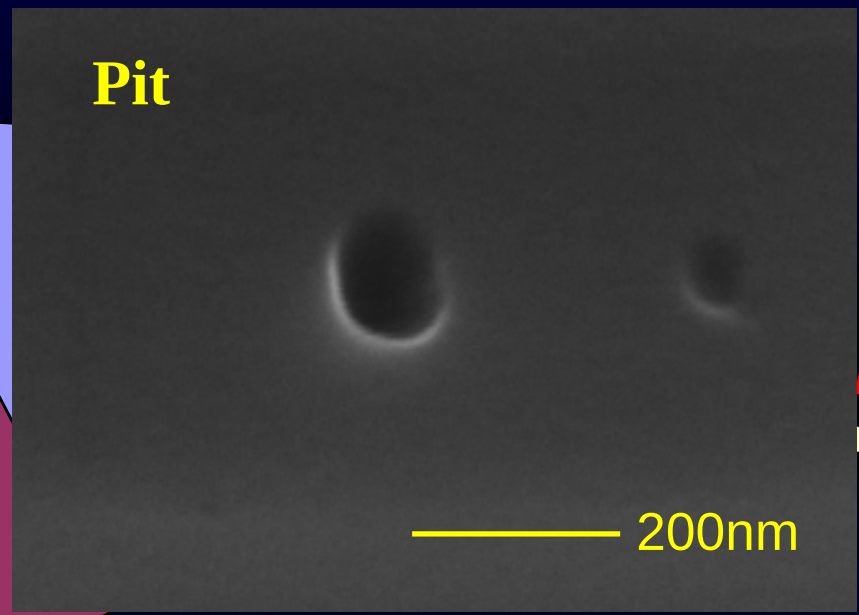


- **Results**
  - **The number of defect is decreasing as schedule**
  - **Defects have been analyzed under various tools and those results will enable us to do the continuous reduction of the defect density**

The classification of defect

- Average of 5 substrates, measured by M1350





- *Re-deposit particle*
  - Reduce contamination of air and liquid
  - Improvement in cleaning

- It is very important to decrease Pit and Un-removable particle

Conclusion

Material

- ✓ We have demonstrated the feasibility to produce Ti-doped silica glass which shows zero expansion
- ✓ Newly developed modified Ti-doped silica glass by AGC achieves extremely low CTE in wide temperature range
- ✓ In Asahi process, the striae of Ti-doped silica glass could be controlled

Surface finishing and metrology

- ✓ Newly developed flatness measurement tool achieved extremely low distortion of substrate holding and good repeatability
- ✓ We have demonstrated the 45nmPV flatness, 97% within 20nmPV, by flatness correction method
- ✓ We have developed innovative technology for reducing defects, and demonstrated 0.06defects/cm2(>60nm)

AGC will start sample delivery of polished substrates for EUVL application from 2005 upon customer's request.