Evaluation Results of a New EUV Reticle pod based on SEMI E152-0709

Kazuya Ota, Masami Yonekawa, Takao Taguchi and Osamu Suga
MIRAI-Semiconductor Leading Edge Technologies, Inc.
20/10/2009@Praha

Semiconductor Leading Edge Technologies, Inc.

Abstract

In 2004, *Canon* and *Nikon* jointly proposed a new pod concept for EUV reticles, *"Dual Pod Concept"*; a mask is doubly protected by an inner pod and an outer pod and the mask is carried into an exposure tool with the inner pod. Canon, Nikon and Entegris have started collaboration in 2005 and developed three types of EUV pod prototypes, alpha, beta and gamma. The dual pod concept was standardized as SEMI E152-0709 “Mechanical Specification of EUV Pods for 150mm EUVL Reticles” this year. Canon, Nikon and Entegris have developed a new pod design ***"cnPod"*** compatible with SEMI E152; it has a type A inner baseplate for uses with EUV exposure tools. The baseplate has two alignment windows, a window for the data matrix symbol and five exclusion volumes for front edge grip.

MIRAI-Selete has executed many shipping tests, vacuum handling tests and vacuum outgassing tests on the cnPod and the results are reported in this paper.

SEMI E152-0709 - Mechanical Specification of EUV Pod for 150 mm EUVL Reticles

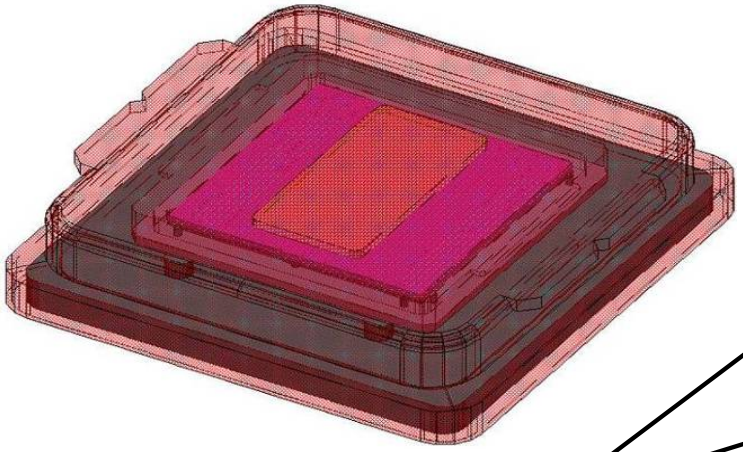
Standard History:

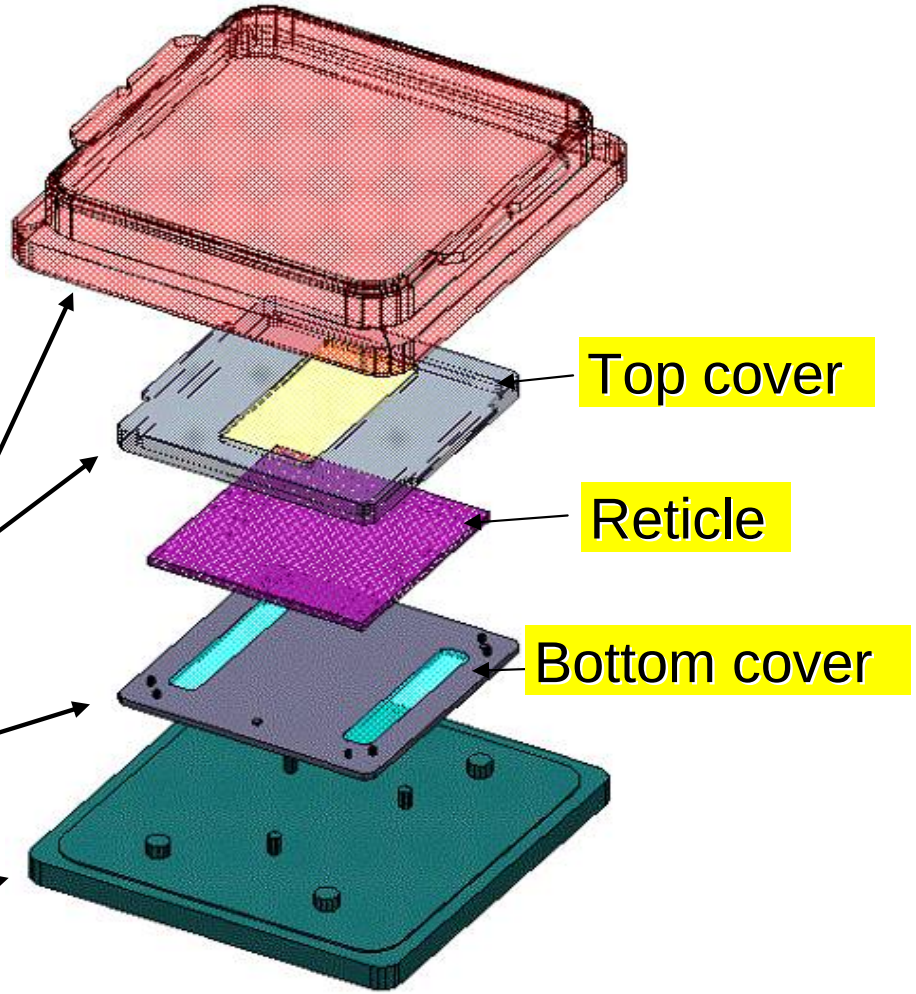
- 11/04, **Concept proposal** – *"A New Concept of EUV Reticle Particle Protection in Handling and New Carrier Standard Proposal"* by Canon & Nikon.
- 5/07, **Blue ballot** – 4466blue *"SPECIFICATION FOR CARRIER AND PROTECTIVE INNER POD SYSTEM USED TO TRANSPORT AND INSTALL EUV RETICLES INTO EXPOSURE AND METROLOGY TOOLS"*
- 2/08, **1st Yellow ballot** – 4466 *"MECHANICAL SPECIFICATION FOR A 150mm EUVL RETICLE SMIF POD (EUV POD)"*
- 9/08, **2nd Yellow ballot** – 4466A *"MECHANICAL SPECIFICATION OF A DUAL POD FOR 150mm EUVL RETICLES (EUV POD)"*
- 1/09, **3rd Yellow ballot** – 4466B *"MECHANICAL SPECIFICATION OF EUV POD FOR 150mm EUVL RETICLES"*
- 7/09, **Published**

Dual Pod Concept

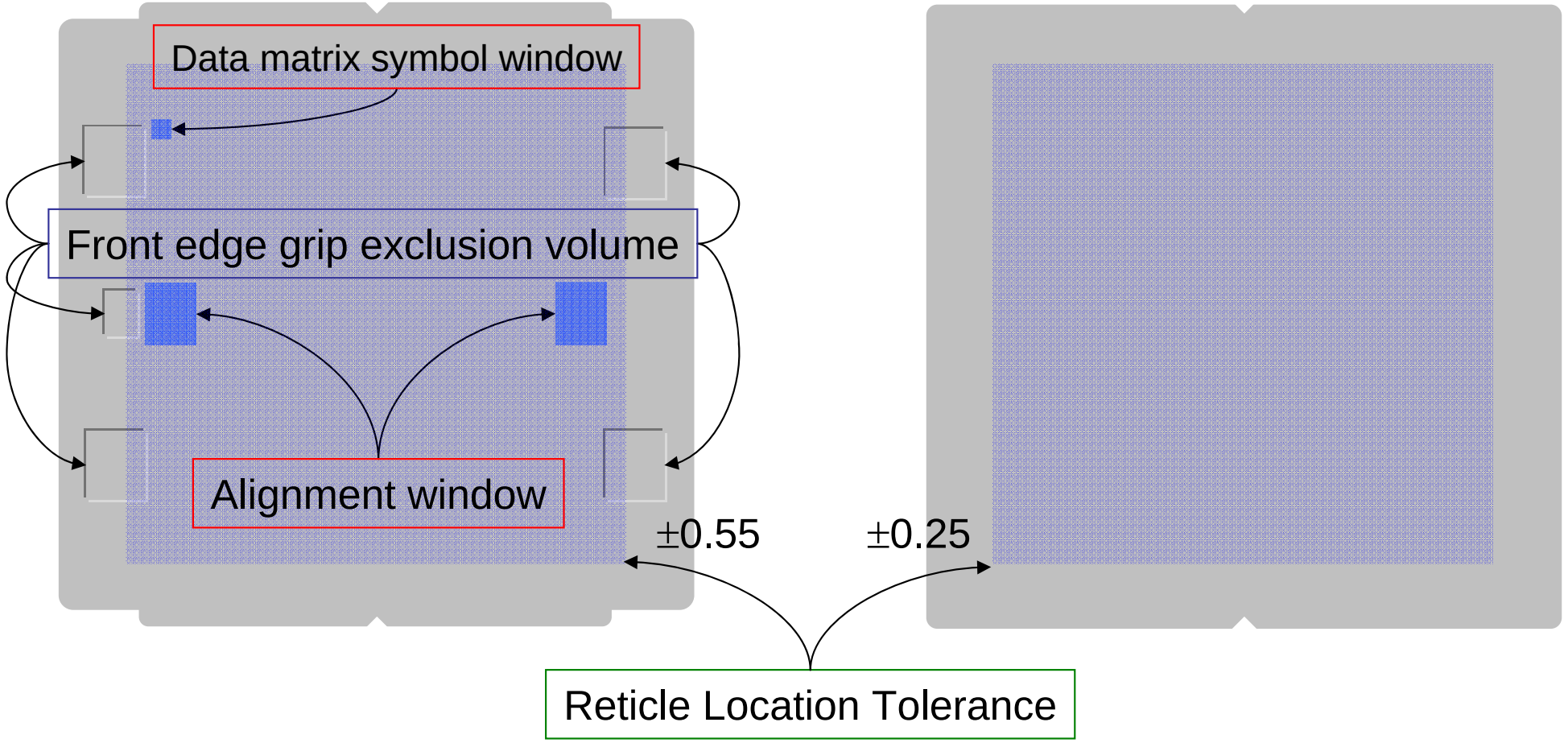
- "Dual Pod Concept" has been jointly proposed by Canon and Nikon at EUV mask technology and standards workshop at Miyazaki in November 2004.

1. Reticle in Cassette in Carrier (reticle SMIF pod - RSP).
2. Cassette protects the reticle in loadlocks.
3. Top cover stays with reticle during in-tool handling.
4. Reticle remains in Cassette in library to protect against vacuum accidents and contamination.





Type A/B Inner Pod Baseplate Specifications



Type A
(For all purposes)

Top View

Type B
(Other than exposure tools)

cnPod Photos

Outer pod

A modified RSP200 is used as the interim outer pod shell and the production outer pod shell is under fabrication.

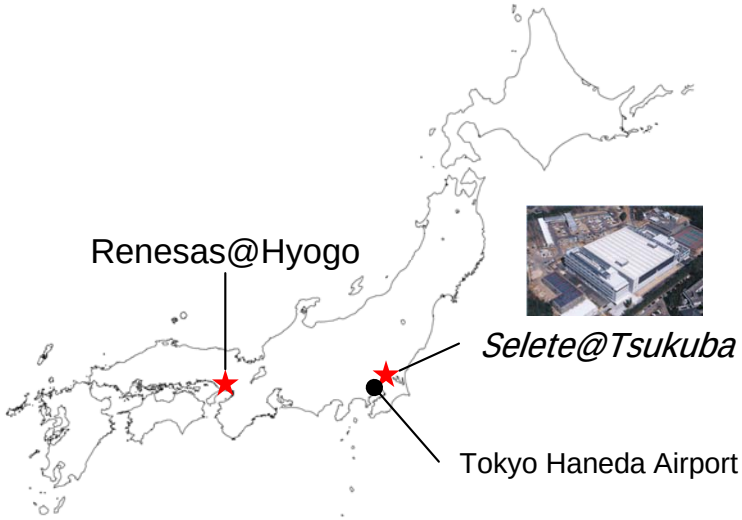
Inner pod

Both the inner cover and the inner baseplate are made of metal to reduce outgassing rate.

Shipping Test Summary

- Selete carried out 5 shipping tests with two cnPods, #1 & #2.





Particle adders during shipping

		1st	2nd	3rd	4th	5th
cnPod #1	QA	3	1	0	0	0
	EA	2	1	0	0	0
cnPod #2	QA	0	0	0	0	13
	EA	0	0	0	0	0

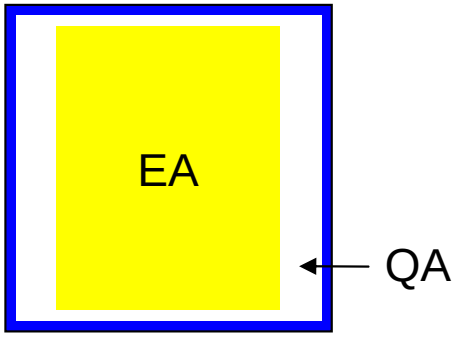
Ave.	
QA	1.7/ship
EA	0.3/ship

CNE gamma	
QA	0.1/ship

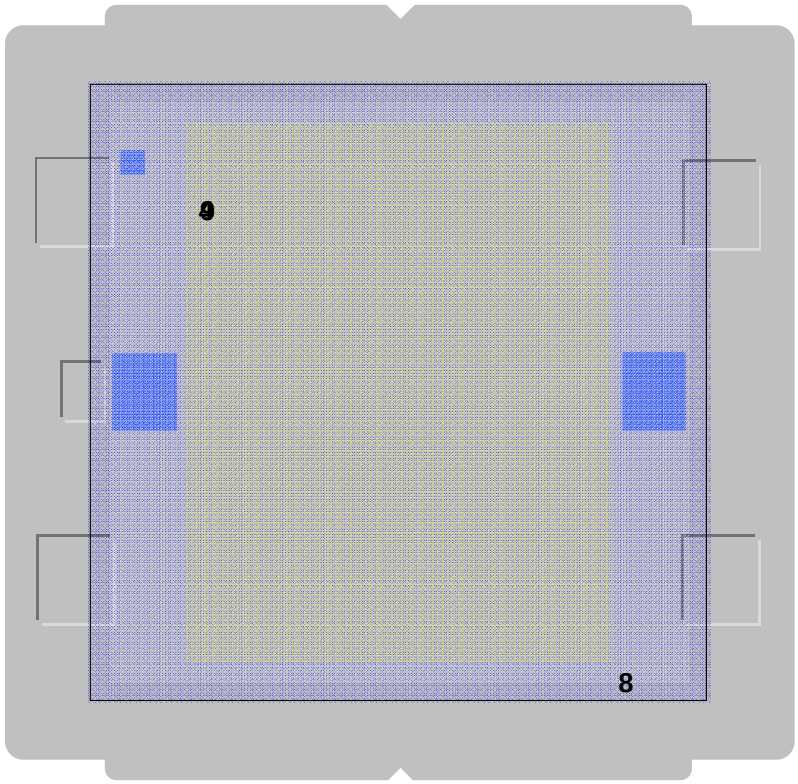
PMJ2008

Lasertec M3350, >= 4pix(46nmPSL)

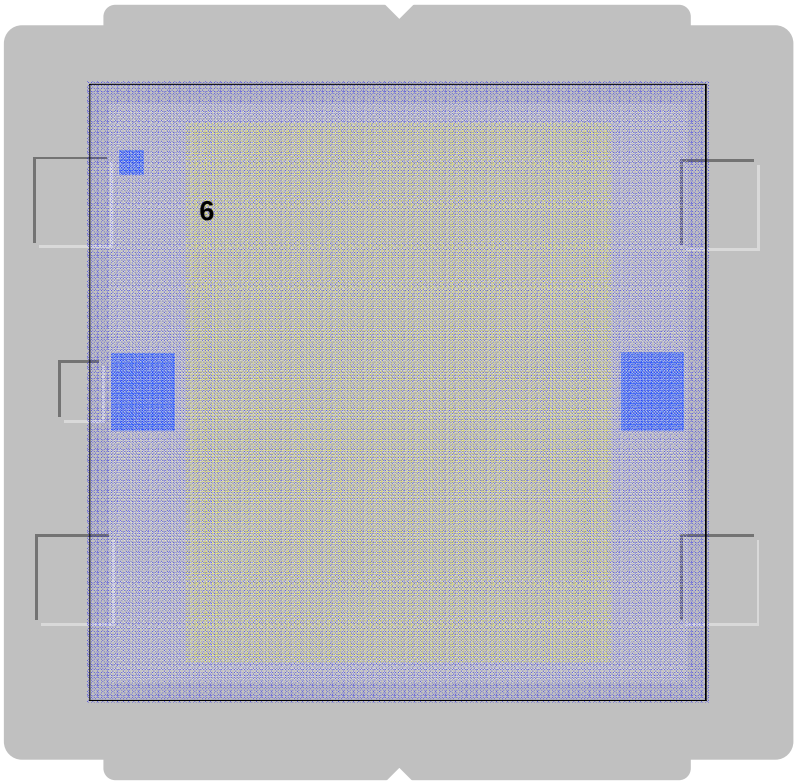
QA: Quality Area, 142 x 142 mm^2
EA: Exposure Area, 104 x 132 mm^2



Shipping Result Details (1) <cnPod #1>

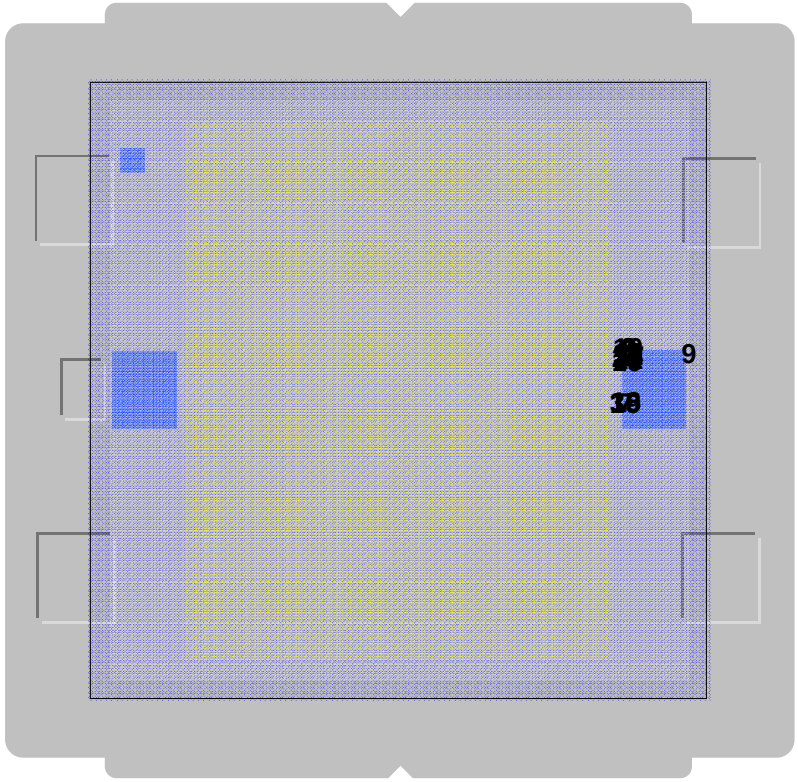


1st shipping adders



2nd shipping adders

Shipping Result Details (2) <cnPod #2>



5th shipping adders

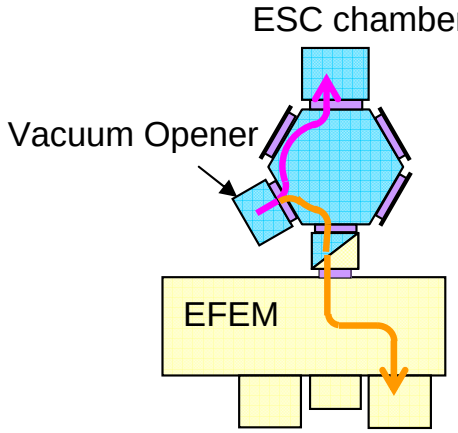
- No adders 1st to 4th shipping.
- 13 adders 5th shipping.
- All adders near the window edge.
- All adders outside EA.

The current windows have not been manufactured as designed by mistake, so there is a problem of the fitting between the windows and the baseplate.

Vacuum Handling Test Summary

- Selete carried out vacuum handling tests using Selete MPE Tool (Mask Protection Engineering Tool).

MPE Tool



Transfer Path

Loop;
- Inner pod: Outer pod@EFEM → Load/Lock → Vacuum opener
- Inner cover removed
- Inner base: Opener → ESC chamber (not chucked) → Opener
- Inner cover closed
- Inner pod: Vacuum opener → Load/Lock → Outer pod@EFEM

End;

Particle adders during vacuum handling

Unit: adder/cycle

Test # (cycles)		Test1 (283)	Test2 (200)	Test3 (486)	Test4 (237)	Test5 (246)	Test6 (459)
cnPod #1	QA			13		4	8
	EA			1		0	1
cnPod #2	QA	3	1		41		
	EA	0	0		20		

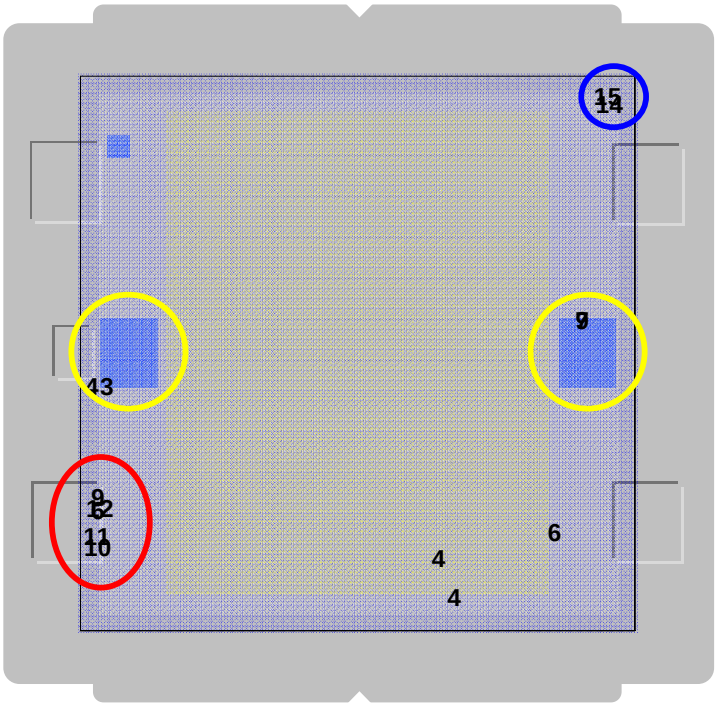
Lasertec M3350, >= 4pix(46nmPSL)

Ave.	All	Test4 excluded
QA	0.037	0.015
EA	0.012	0.001

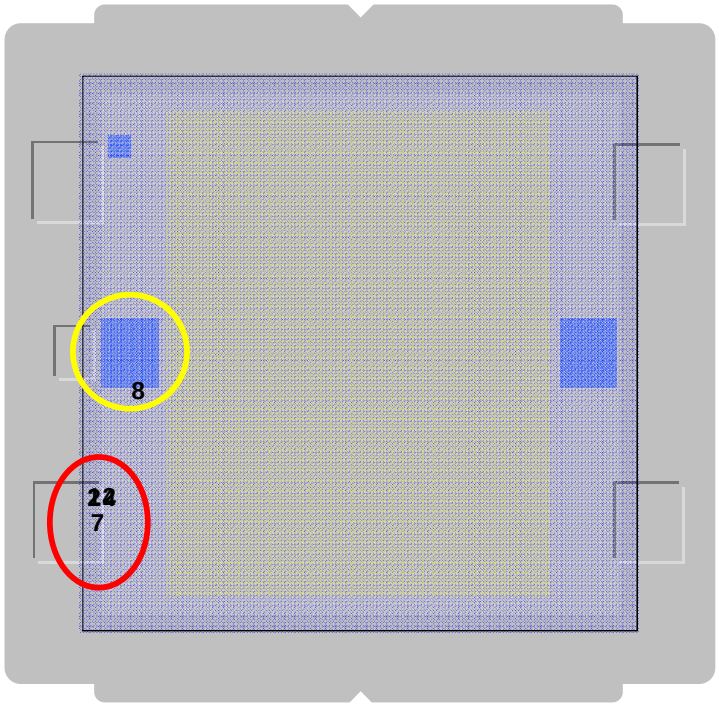
CNE gamma	
QA	0.008

SPIE2008

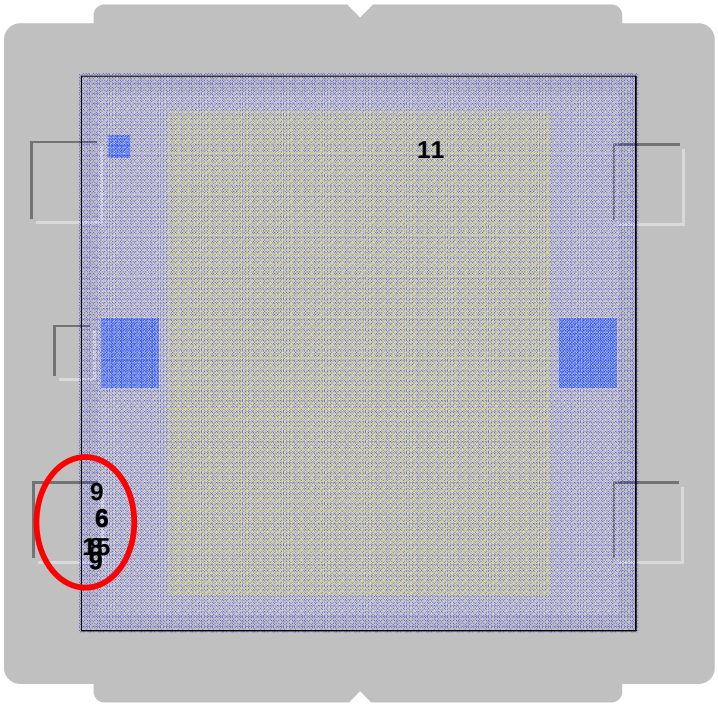
Vacuum Handling Result Details (1) <cnPod #1>



Test 3



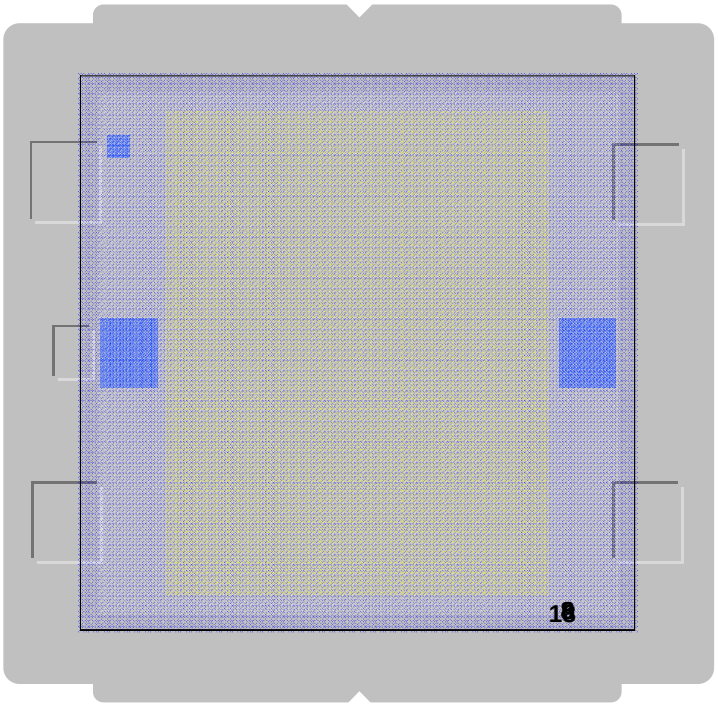
Test 5



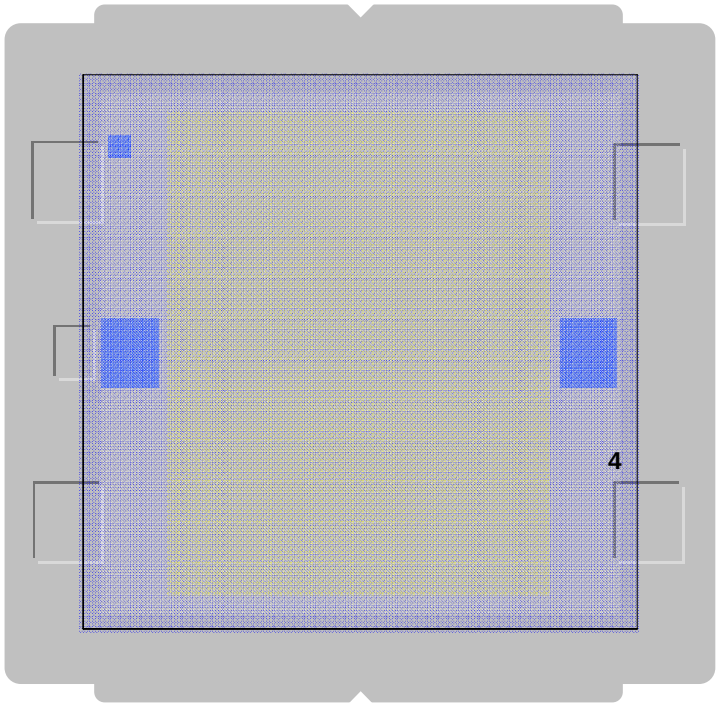
Test 6

- Only one adder inside EA.
- Many adders near the lower left pocket.
- A few adders near the alignment window.
- A few adders near the upper right support pin.

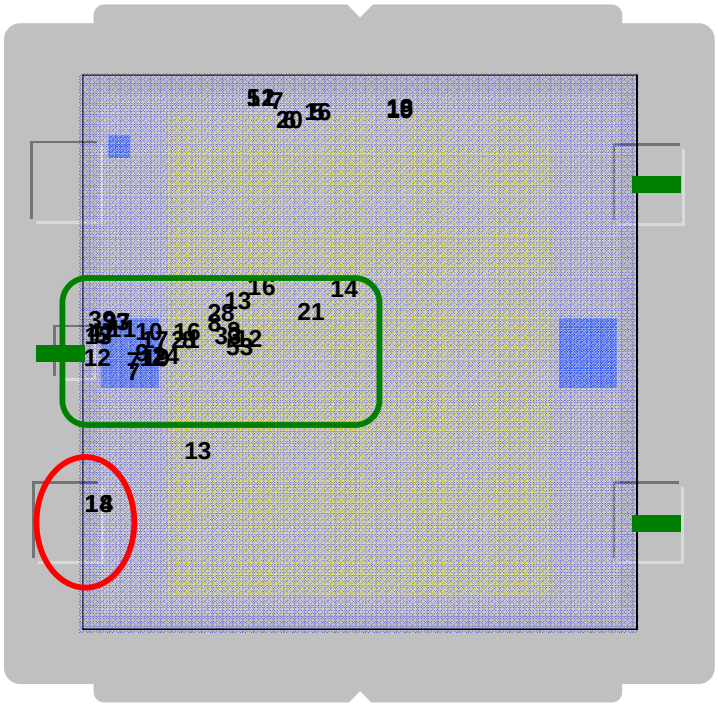
Vacuum Handling Result Details (2) <cnPod #2>



Test 1



Test 2



Test 4

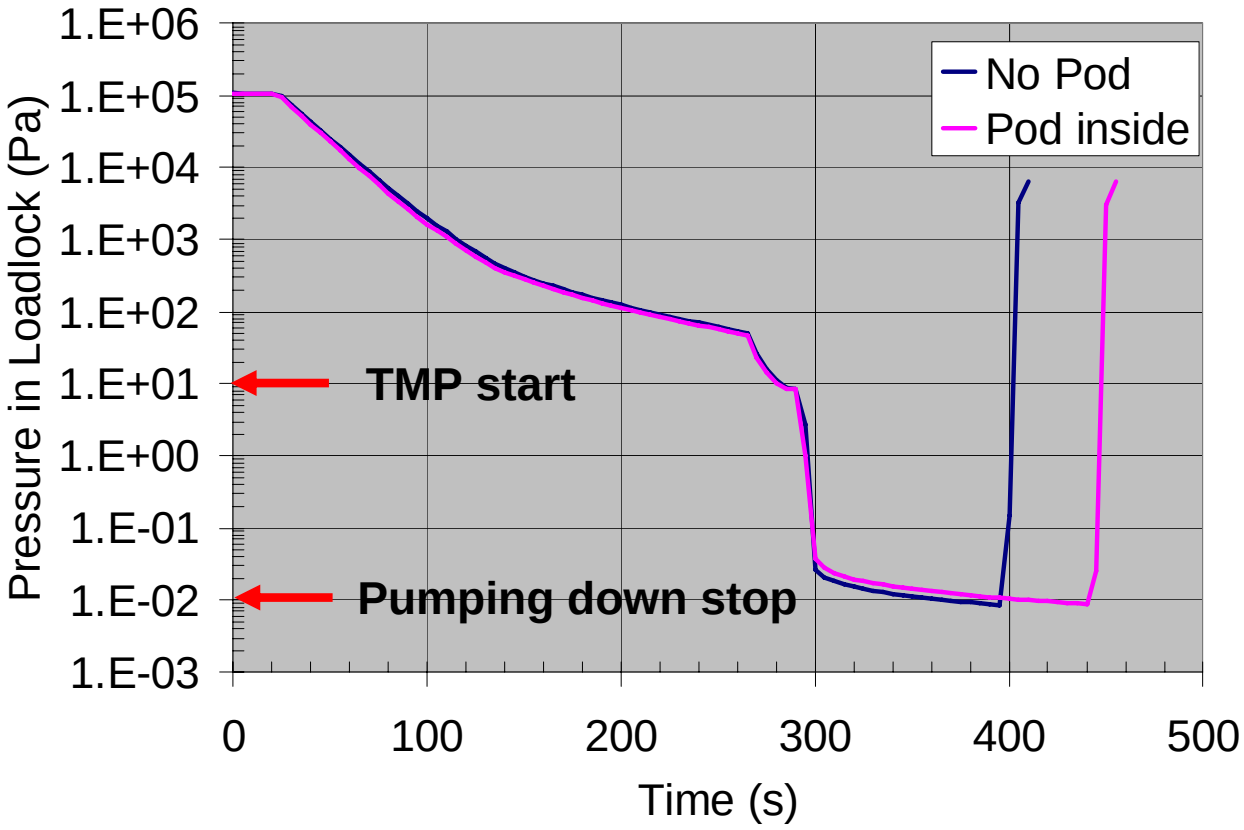
- No adders inside EA in test 2 & 3.
- A few adders near the lower left pocket.
- Many adders near the left edge gripper.

M3350 grippers

Something may have happened when the substrate was gripped at M3350 which was designed on the assumption that "Reticle Location Tolerance" was ±0.25mm.

Vacuum Outgassing Test Summary

- Pumping down speed in the loadlock of MPE Tool was measured.



- TMP started at <10 Pa.
- Pumping down stopped at <1E-2 Pa.
- TMP capacity: 80 l/s
- Loadlock capacity: 17 l

(Outgassing rate of cnPod w/ substrate) + (Pod conductance factor) < 2.5E-4 ($Pa \cdot m^3/s$)

We will do further tests to know the outgassing rate of the cnPod.

RELATED INFORMATION 1 (SEMI-E152)

R1-2 *Vacuum outgassing* **–** A suggested maximum outgassing rate of the inner pod permitted for handling in exposure tools is:
6.5E-5 $Pa.m^3/s$ for all species (primarily H_2O); and
6.5E-7 $Pa.m^3/s$ for hydrocarbon species

Conclusions

- A new SEMI standard "E152-0709" has been published in July 2009, where the dual pod concept was jointly proposed by Canon and Nikon in 2004. A new SEMI compliant EUV pod "cnPod" has been developed by Canon, Nikon and Entegris. MIRAI-Selete has evaluated the performance of the cnPod.
- The cnPod can have the equal particle protective performance as the CNE gamma inside the exposure area: 0.3 adders per shipping and 0.012 (0.001) adders per vacuum handling. But several issues are found outside the exposure area; they may be related to the modifications to meet the SEMI specifications.
- The pumping down speed of the loadlock chamber w/ a pod and w/o a pod was compared and the potential lower outgassing rate of the cnPod was confirmed.

Acknowledgements

- We appreciate the effort of Takashi Kamono (Canon) and Tsuneyuki Hagiwara (Nikon), David Halbmaier (Entegris) and John Lystad (Entegris) in developing and supplying the cnPods.
- We would like to thank Shuichi Matsuda (Renesas Technologies) for his support on shipping tests.
- This work is supported by NEDO as a part of the EUV mask program.