Robotics, Shipping, Storage, & Vacuum

IEUVI (Mask), San Jose, CA, 02.15.07

Long He

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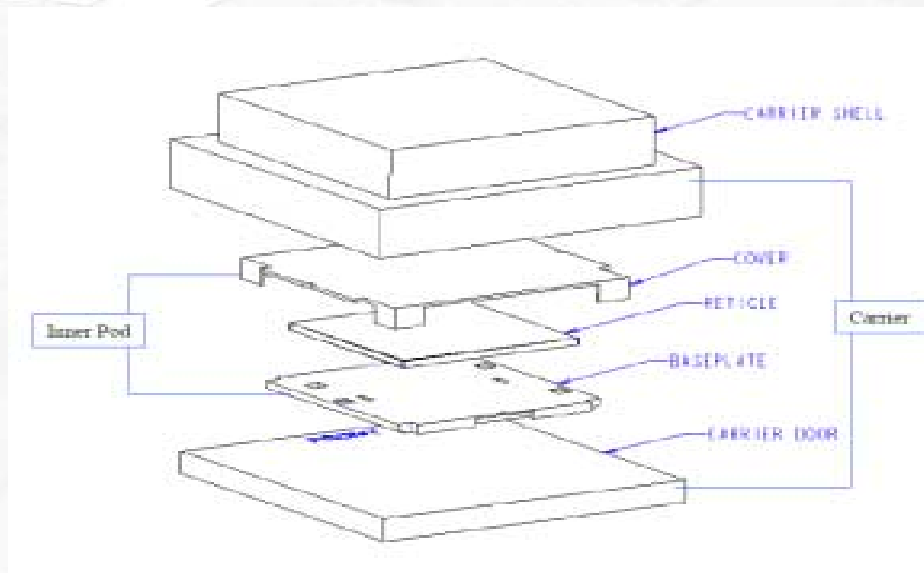
Outline

- **standard & infrastructure**
- **sPod baseline data**
- **Assessment in meeting 32 nm hp requirements**

EUV Reticle Handling Standard (SEMI-4466) is Out For Voting

- **SEMI 4466 Yellow ballot voting started on 2/22, ends in 4 weeks.**
- **Key technical elements include**
  - Contact area: Reticle exclusion area and reticle handling exclusion volume
  - Inner pod: Base plate, cover, interface
  - Outer pod: 200 mm SMIF pod interface standard
  - Loadport: 200 mm SMIF loadport interface



Schematic of EUV reticle carrier

He, et al. (SPIE 2008, 6921-66)

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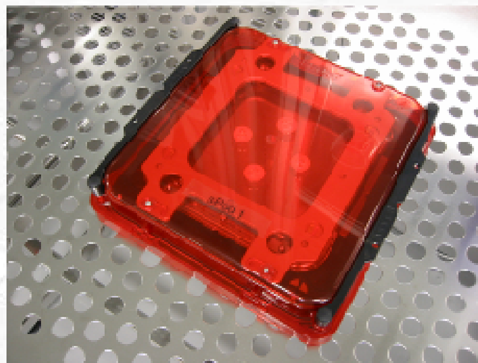
EUV Reticle Handling Infrastructure @SEMATECH

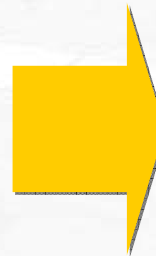
- Minimal set of reticle handling infrastructure required

Carrier cleaning



Carrier (sPod)

Robotic interface (between 4 types of carrier)



Applications (shipment, etc …)

He, et al. (SPIE 2008, 6921-66)

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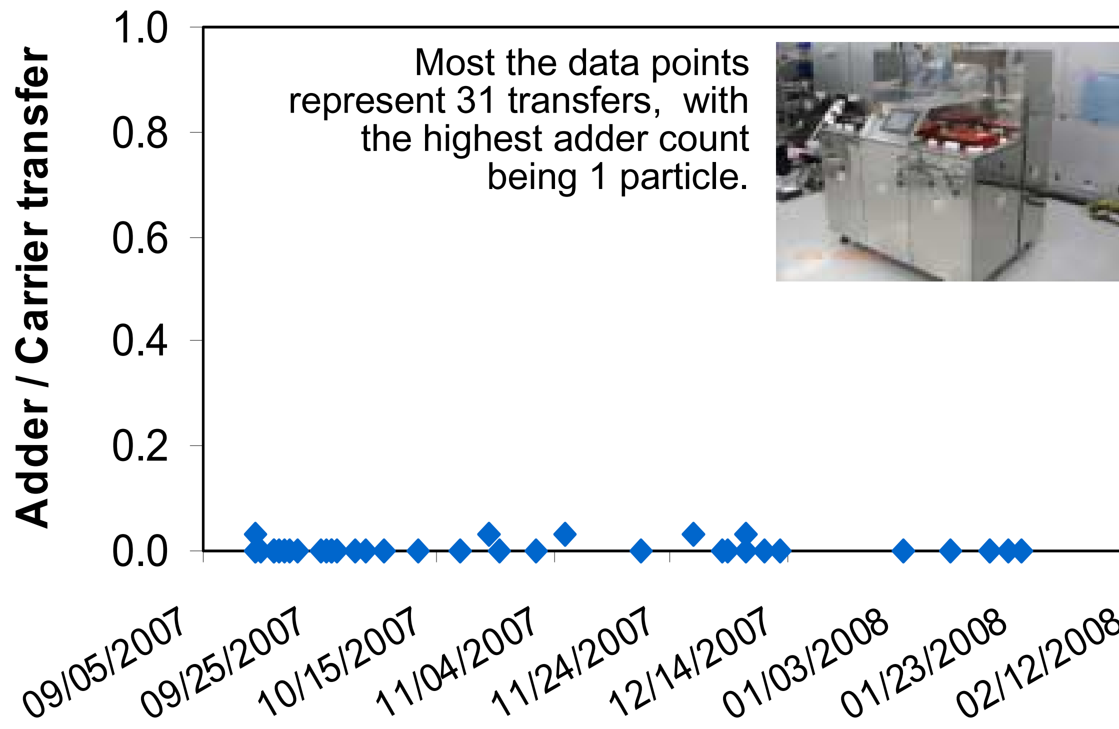
sPod Carrier Can Be Interfaced/Handled *Cleanly*

- **Baseline performance: <1 particle/200 transfers, @53 nm, state-of-the-art inspection capability**
- **Reticle transferred between sPod and RSP200 SMIF pod, using robots at SEMATECH**
- **Data here represent the carrier transfer tests of over 40 runs and 2,000 transfers for a period of 5 months.**



He, et al. (SPIE 2008, 6921-66)

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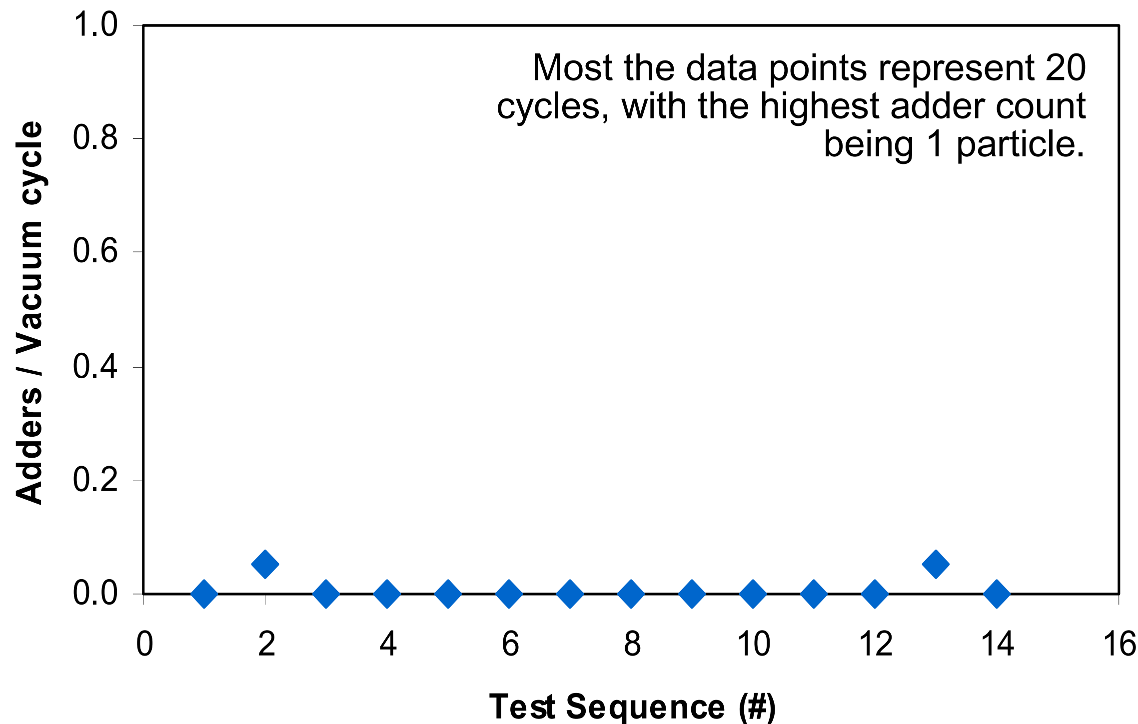
sPod Provides Defect-free Vacuum Protection

- **Baseline performance: <1 particle per 100 vacuum (4 mTorr) pump/vent cycles, @53 nm inspection capability**
- **Inner pods (of sPod) mounted *manually* in chamber for vacuum pump/vent cycle tests**
- **Data here represent 14 such tests of a total of ~300 vacuum cycles.**



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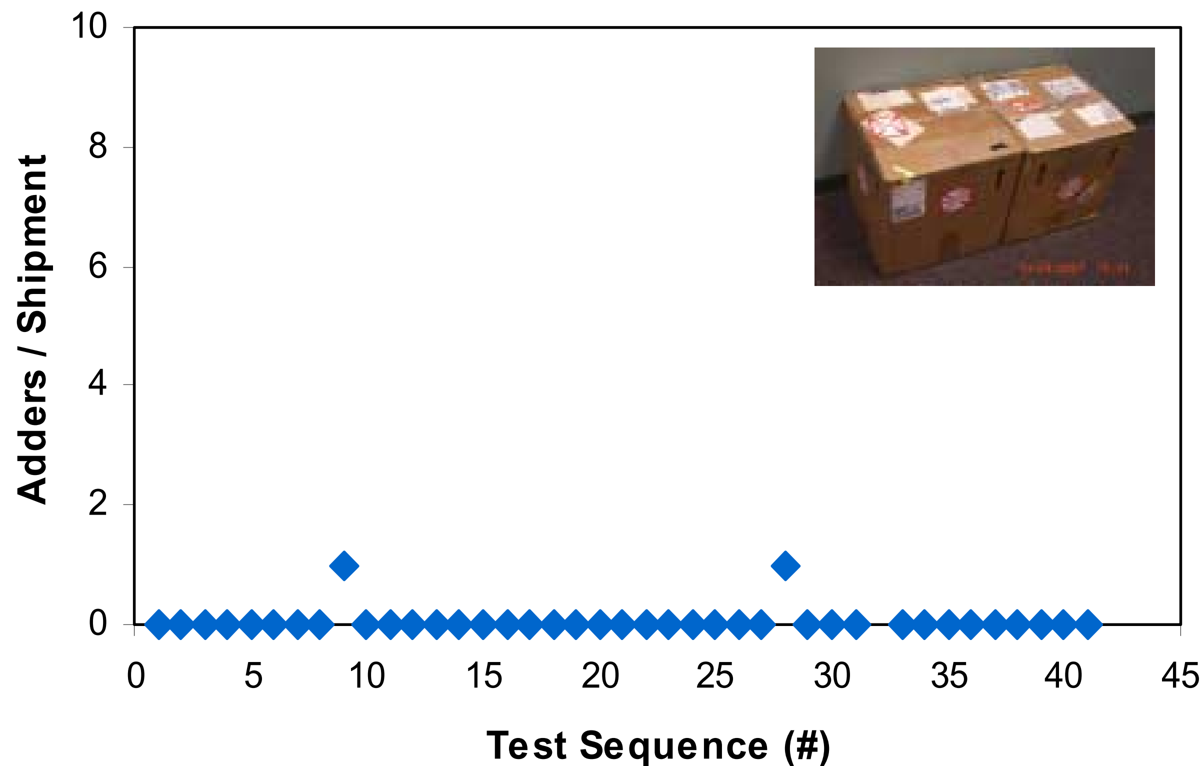
He, et al. (SPIE 2008, 6921-66)

sPod Provides Defect-Free Reticle Shipment

- **Baseline performance: < 0.1 particles/roundtrip shipment, @53 nm inspection capability**
- **Shipped between Albany, NY, and Austin, TX, by commercial shippers**
- **Data represent about 40 tests over a period of 4 months**



He, et al. (SPIE 2008, 6921-66)

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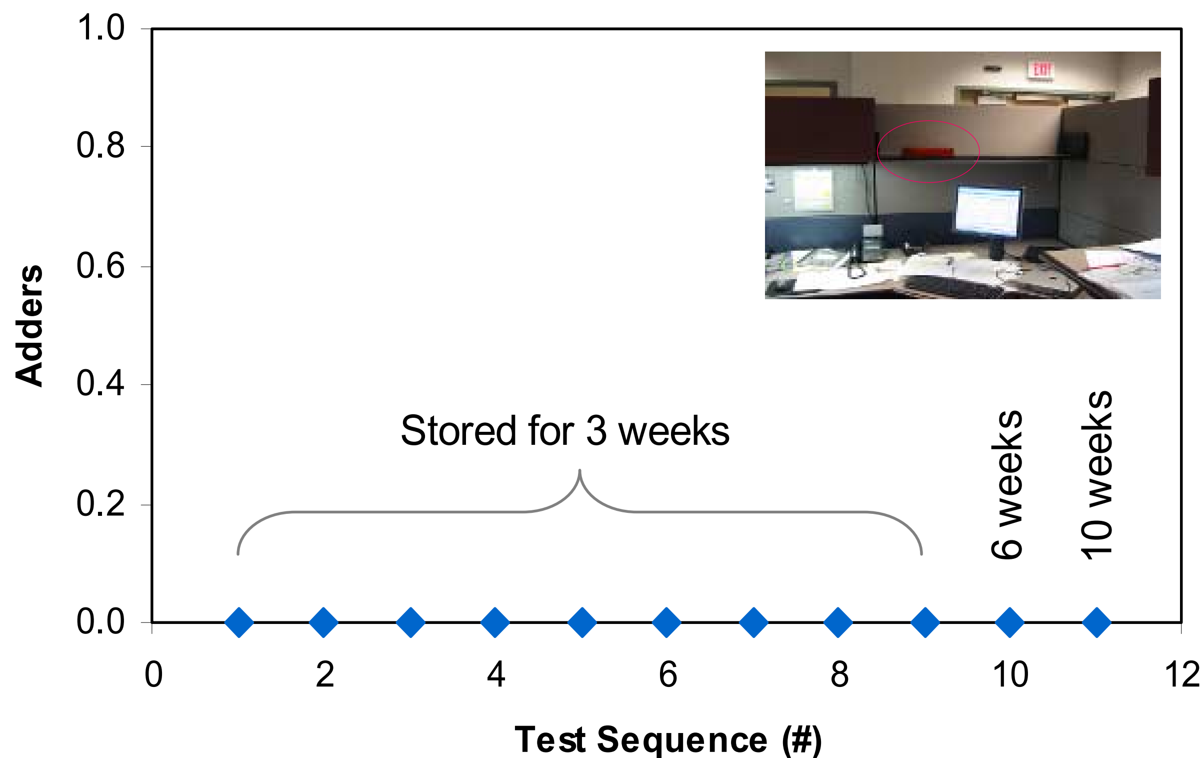
sPod Provides Defect-Free Reticle Protection for Storage

- **Baseline performance: 0 adders in all such tests, @53 nm inspection capability**
- **sPods stored *unbagged* in a standard office environment for 3, 6, and 10 weeks**



Looks too good to be true… but ***data is data!***

He, et al. (SPIE 2008, 6921-66)

sPod Carrier Proves Robust for Integrated Reticle Shipment and Storage

- **Integrated tests for shipment and accelerated storage in standard office environment show particle-free protection**

  Test description:
  - Shipped round trip between Albany, NY, and Austin, TX
  - Then, stored unbagged in a standard office area for 3 weeks
  - All 5 sPods provided defect-free protection, @53 nm inspection capability

Round-trip shipment: Albany - Austin

+

Then, stored in standard office environment for 3 weeks

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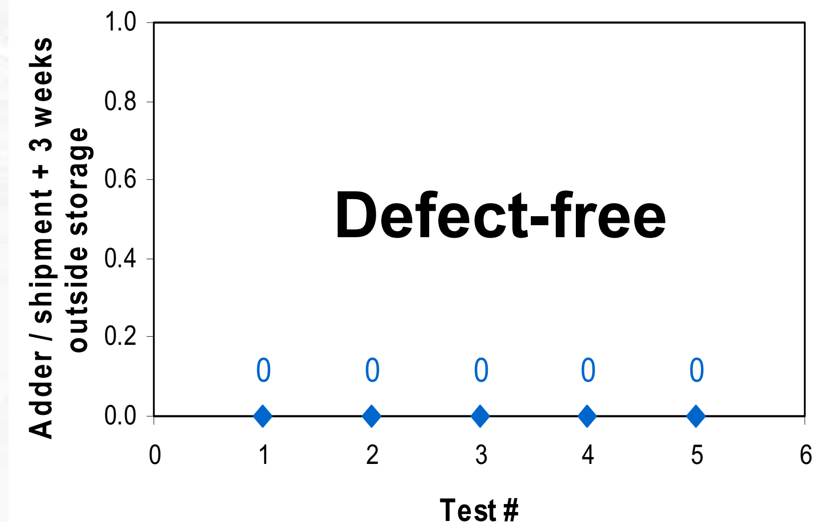
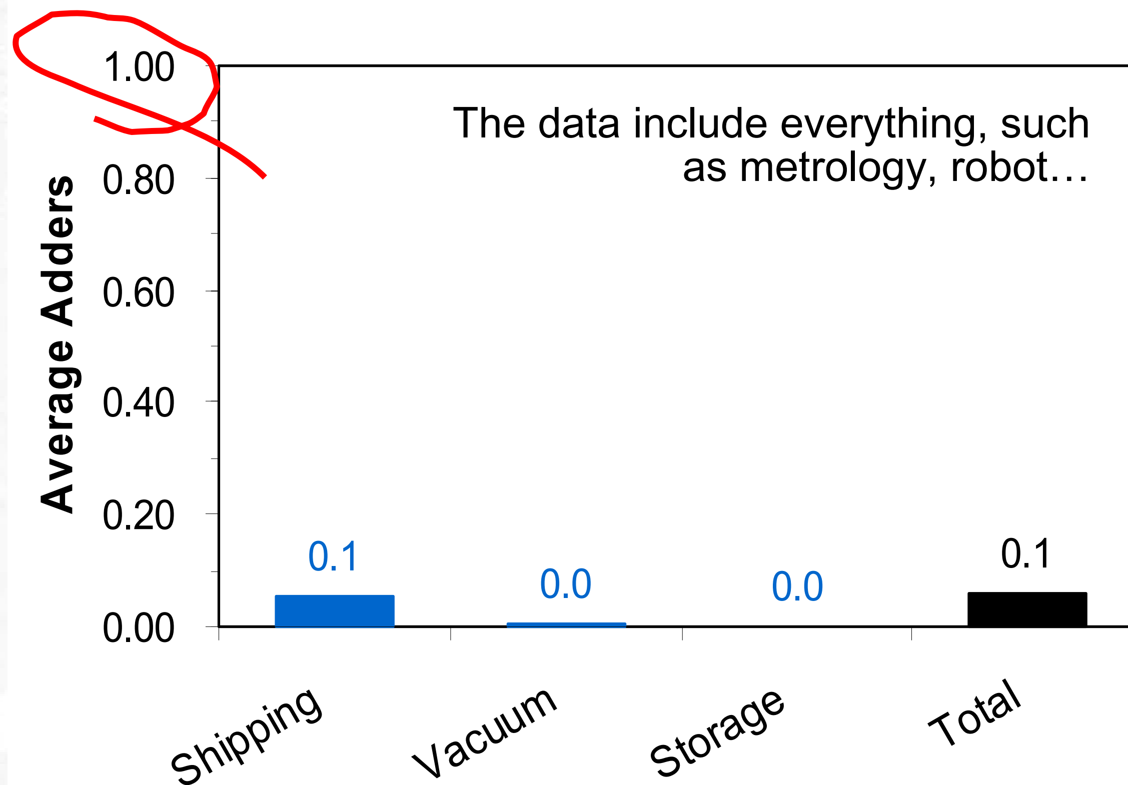


He, et al. (SPIE 2008, 6921-66)

sPod Demonstrates Defect-Free EUV Reticle Handling

- **sPod Baseline Performance: 0.1 adders per lifecycle use**
  - @53 nm PSL equivalent, state-of-the-art inspection capability, and in the central 142 mm x 142 mm area.
  - Lifecycle use includes round-trip shipment, at least 3 weeks of storage in a standard office environment, and vacuum pump/vent (4mTorr).
  - Data collected over a period of 5 months.



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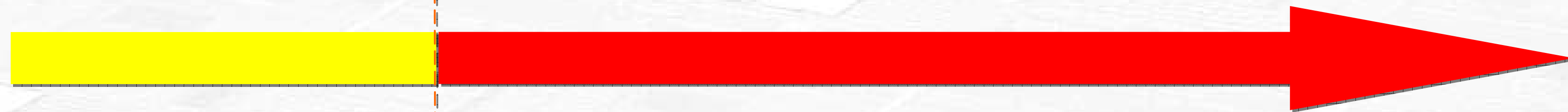
Meeting 32 nm hp Production Needs Requires More Advanced Inspection Capability

Today's Mask Blank Inspection Capability:

1st Gen. Insp. Capability (~53nm)

2nd Gen. Inspection Capability (~35nm)



ITRS:

Part of Table 78c EUVL Mask Requirements ---- Near Term Years						
Year of Production	2008	2009	2010	2011	2012	2013
DRAM 1/2 pitch (nm) (contacted)	57	50	45	40	36	32
Flash 1/2 pitch (nm) (un-contacted poly)	51	45	40	36	32	28
Mask minimum primary feature size (nm)	106	94	84	75	67	59
Substrate defect size (nm)	**38**	**36**	**35**	**33**	**31**	**30**
Defect size (nm)	46	40	36	32	28	26

53 nm

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Meeting 32 nm hp Production Needs Also Requires More Industry Collaboration

- **Critical needs**
  - Defect-free reticle handling for manufacturability. It would be a showstopper if not adequately addressed.
- **Performance gap in meeting 32 nm hp production requirements is *unknown!***
  - Anticipate significant issues below 50, 40 nm and the ***risk is high!***
- **A final 32 nm hp solution requires more industry collaboration**
  - Adopt SEMI 4466 draft standard
  - Commercialize SEMI 4466 compliant carriers to let the learning curve start.
  - Achieve 2nd generation inspection performance of 35 nm capability
  - Develop 3rd generation mask inspection tools for 20 nm capability
  - Further develop reticle handling solution, carriers, and loadports

He, et al. (SPIE 2008, 6921-66)