Accelerating the next technology revolution

Protection Efficiency of SEMI Standard-Compliant EUV Pods

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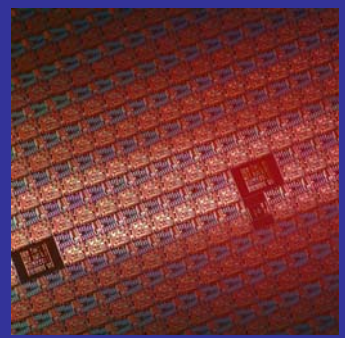

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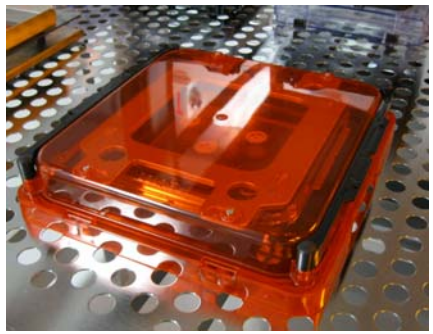
Outline

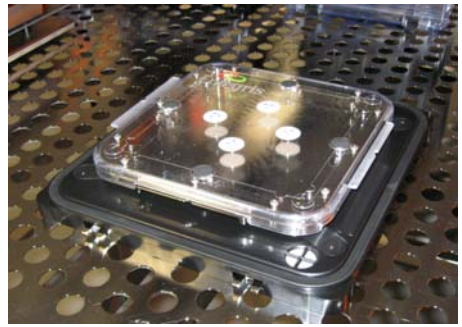
- Introduction
  - SEMI E152-Compliant Dual Pods
- Particle Protection Efficiency Results
  - Robotic transfer in atmosphere
  - Roundtrip shipping between Albany and Austin
  - Storage
  - Transfer from atmosphere to vacuum
- Commercial Outer Pod Status
- Conclusions

sPod1 vs. sPod3 (SEMATECH Pods)

- sPOD1: An early version of an EUV pod

whole pod

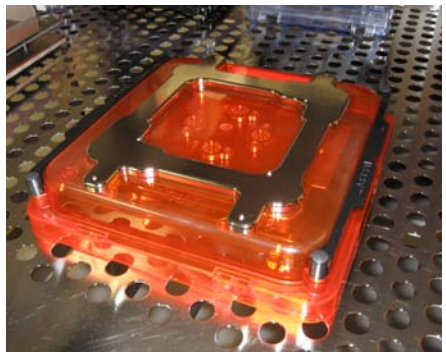


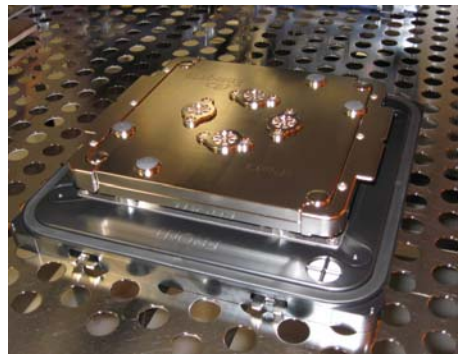


inner pod

- sPOD3: SEMI-compliant version of an EUV pod

whole pod





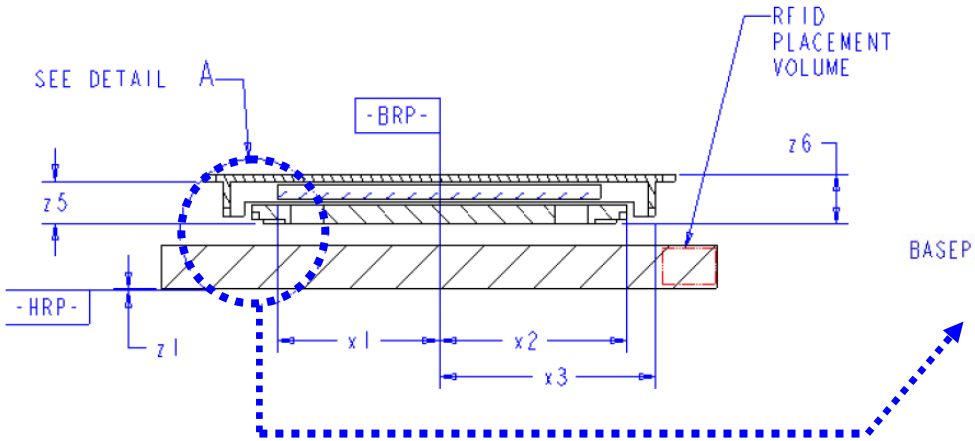
inner pod

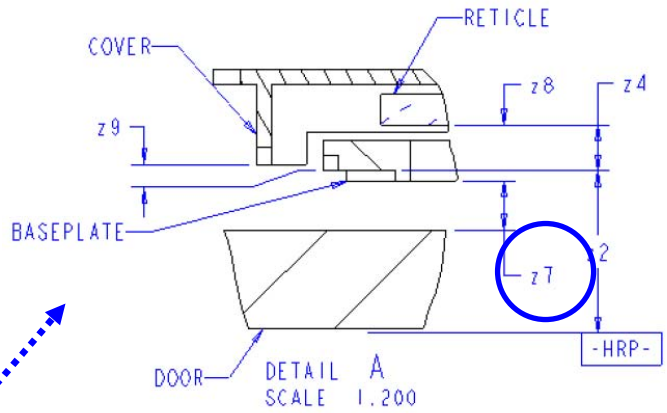
- Limited outer pod room
- Metal frame moved to outside of the outer pod

- Inner Pod: sPod3 has a metallic inner pod construction (aluminum)
- Outer Pod: The prototype outer pod was modified from the old pod with more room to comply with SEMI E152

All SEMI-Compliant Dual Pods

SEMI Standard		Type B (Sematech Type)		Type A (Scanner Supplier Type)
Inner Pod Type		sPod1	sPod3	Scanner supplier type
Outer Pod Type		Prototype 1	Prototype 2	Prototype 2
SEMI Compliance		**Non-compliant**	SEMI-compliant	SEMI-compliant
Z7	>= 10 mm	**3.8**	**10**	**10**
Z8	8.6 +/- .5 mm	8.6	8.71	8.71
Z5	16.25+/-.25 mm	16.3	16.05	16
Z4	6.4+/-.25 mm	-	6.47	6.53



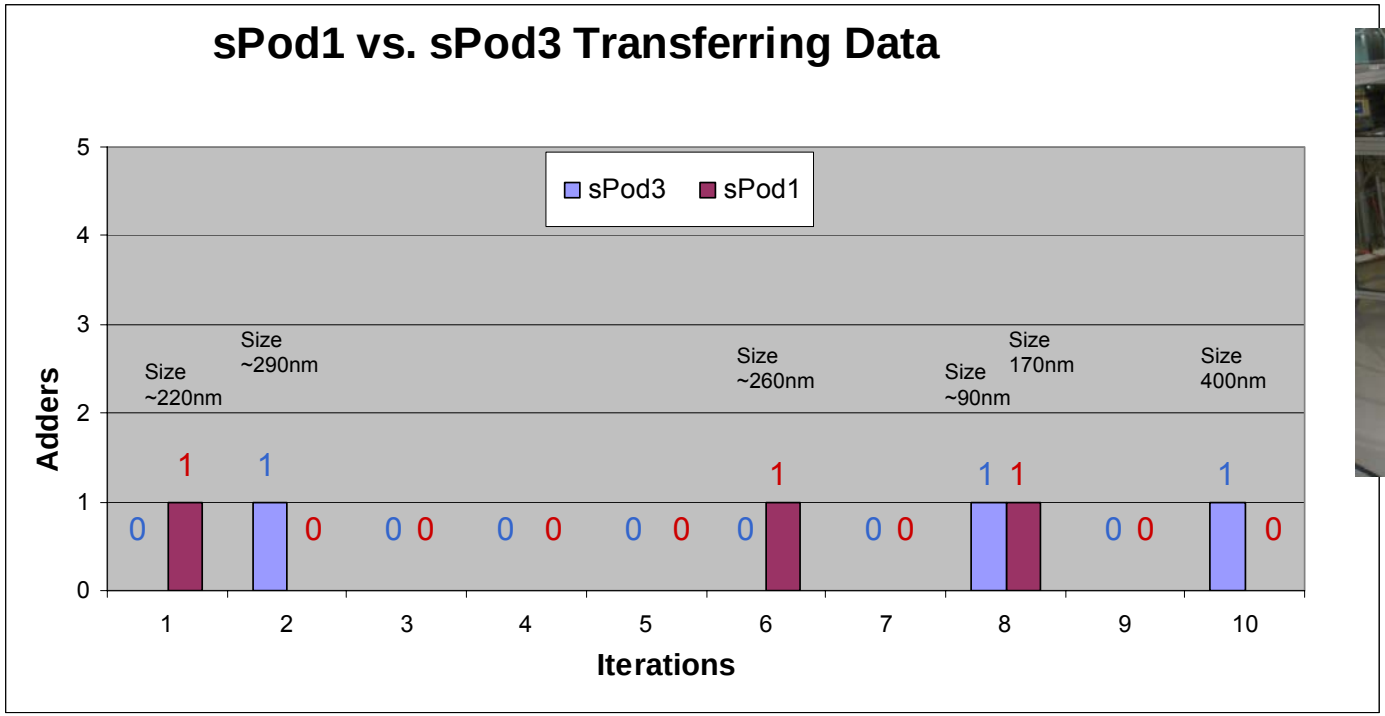


Z7 defines the separation between the bottom of inner pod and top of outer carrier door

- Two types of different SEMI-compliant dual pods were built: type B for SEMATECH and type A for scanner suppliers
- Z7 increased from 3.8 mm (sPod1) to ≥ 10 mm in SEMI standard to facilitate robotic handling

sPod1 vs. sPod3 Robotic Transfer in Atmosphere

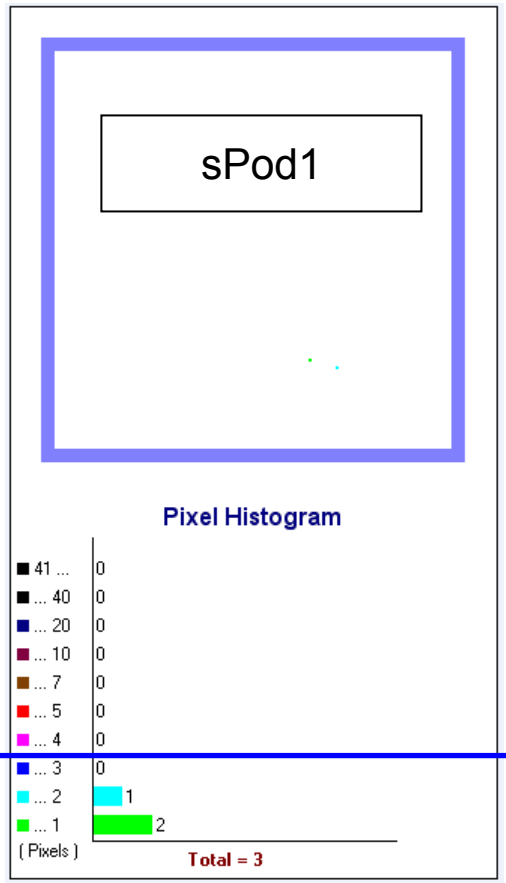
Inspection sensitivity: 48 nm polystyrene latex (PSL) equivalent; inspected area: 142 mm x 142 mm

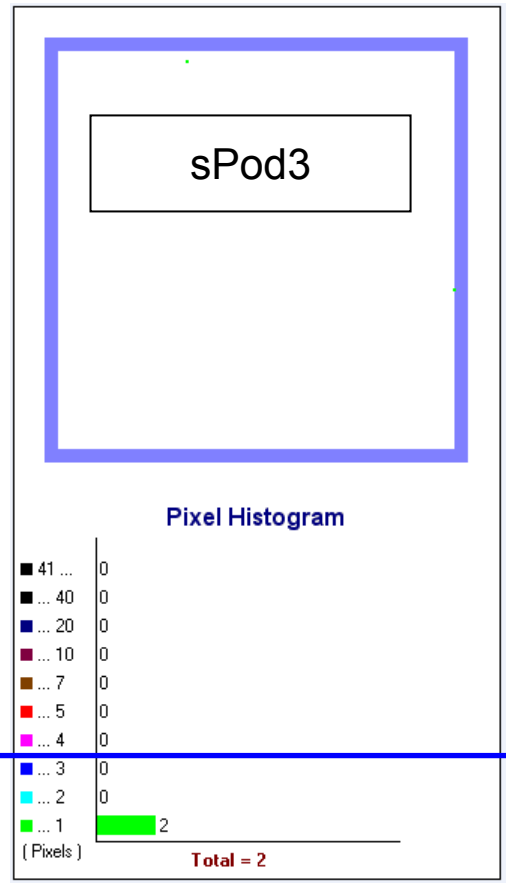


- Every data point represents a 30-cycle transfer test
- Three adders were observed on both sPod1 and sPod3 out of a 300-cycle transfer test
- 0.01 adder/cycle on both the sPod1 and sPod3
- sPod3 and sPod1 demonstrate the same particle protection capability

sPod1 vs. sPod3 Storage Data

Inspection sensitivity: 48 nm PSL equivalent; inspected area: 142 mm x 142 mm



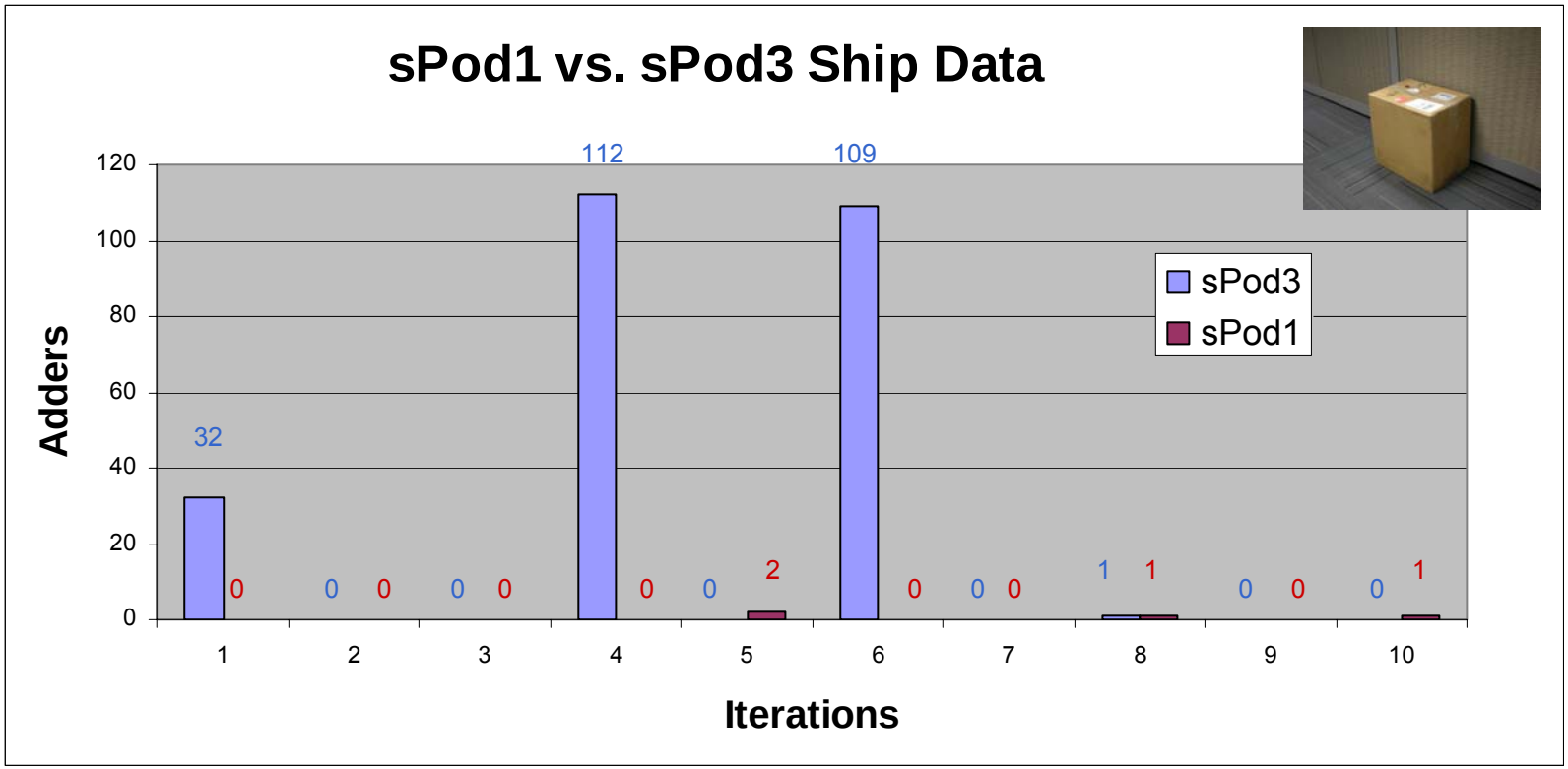


No adders >48 nm

- 2 weeks storage in the office without a bag
- Both sPod1 and sPo3 demonstrate zero particle adders @48 nm and above

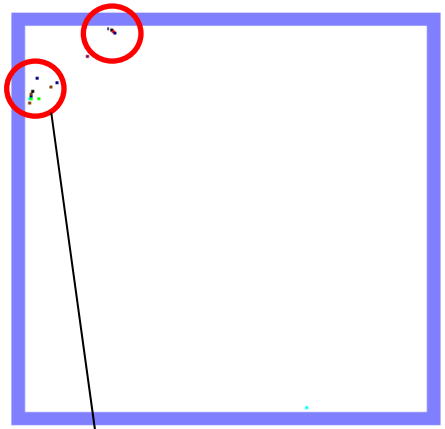
sPod1 vs. sPod3 Ship Data (Albany<-> Austin)

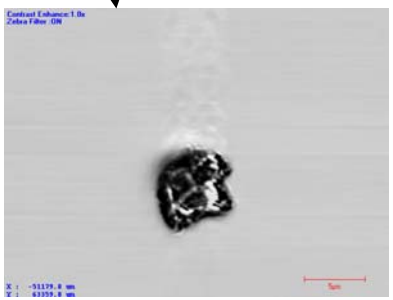
Inspection sensitivity: 48 nm PSL equivalent; inspected area: 142 mm x 142 mm



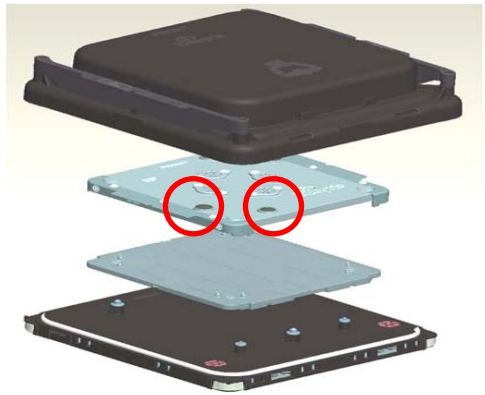
- Each data point represents one shipping round between Albany and Austin
- sPod3 data is not as good as expected—3 high adders reported out of 10 cycles—while sPod1, as control group, remains stable
- sPod3 shipping data is not as good as originally expected

Investigation of sPod3 with High Adders

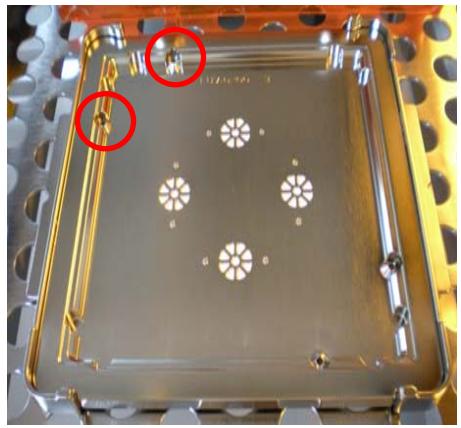




Top of inner pod lid



underside of inner pod lid



- Defect location correlated to restraining pin (made of stainless) pushing on backside of mask
- Particles determined to be stainless steel by EDX
- Rubbing between the backside of the mask and restraining pin during shipping suspected
- Limited space on the prototype outer pod may have led to un-optimized clamping force on the inner pod
- We suspect particles are migrating from the backside to the frontside

Type A EUV-pods

- Shipping tests of Type A EUV-pod with prototype outer pod show similar particle adder patterns
- All tests with both inner pods and production outer pod will start soon
- Type A EUV inner pods must also meet particle adder requirements in vacuum

Vacuum Transfer Data – Type A Dual Pod

- Zero adders @46 nm PSL over 142 x 142mm² from 219 cycles of transfer from atmosphere to the reticle chucking vacuum chamber
  - The inner cover was removed from the opener chamber in vacuum
  - No chucking action was performed in this test
- The SEMI-compliant dual pod provides excellent particle protection in the vacuum transfer test
- The vacuum tests are being repeated to confirm the stability of SEMI-compliant dual pods

Prototype Outer Pod Summary

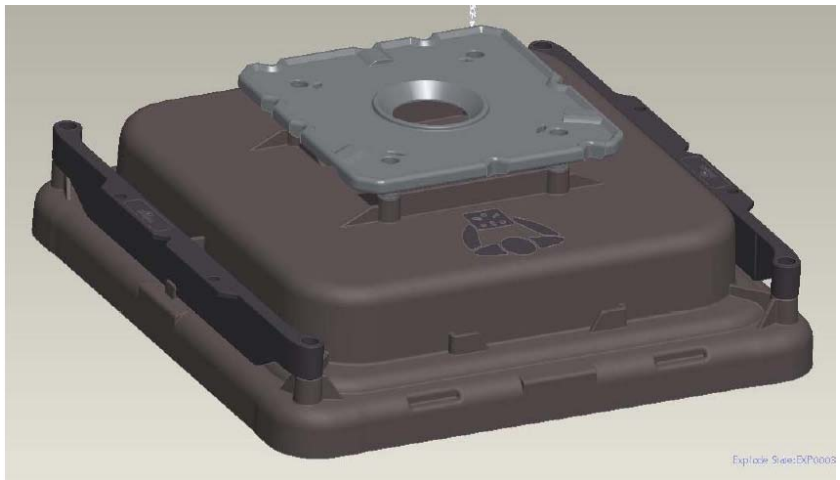
- The prototype outer pod, modified from an existing RSP pod, performed well on the robotic transfer test, storage test, and vacuum test
- The prototype outer pod had particle adders during the shipping test, most likely because of
  - Increased height of inner pod (Z7), kinetic behavior changed
  - Insufficient room to accommodate lifted inner pod
  - Insufficient room to allow for optimum inner pod clamp design
- A newly designed commercial outer pod will be tested again to confirm the shipping test results

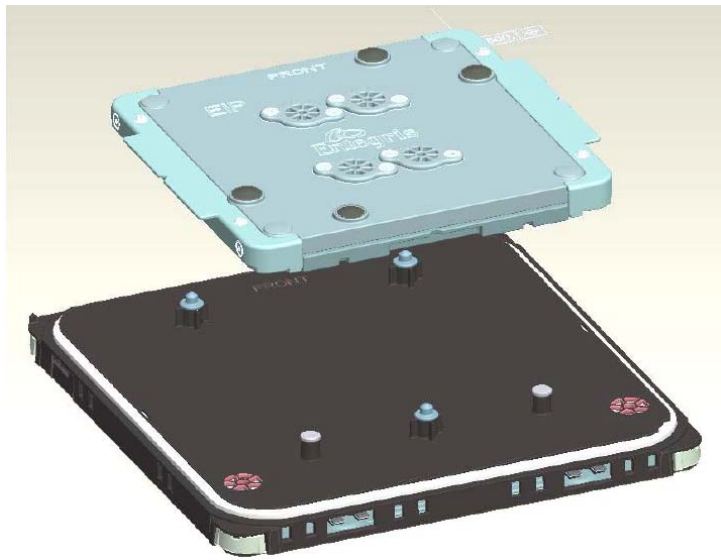
Production Outer Pod

- The goal is to develop a single commercial outer pod that can be used by all SEMI-compliant inner pods
- 4 sample production outer pods arrived at SEMATECH in October
- The performance test will be completed in October
- The final commercial outer pods will be delivered to SEMATECH in November
- Commercial outer pods will be available for all users by the end of 2009
- Contamination and reliability data will be reported at SPIE in 2010

Production Outer Pod

- Fully compliant with E152
  - Side Handles
  - Card Holder Slots
  - Optional Top Robotic Flange
  - Increased Rigidity for Door
  - Polycarbonate (PC) with Carbon Addictive
  - ESD, Outgassing
  - Particle Protection





Conclusions

- SEMI-compliant dual pods proved to be as good as the sPod1 in the robotic transfer test, storage test, and vacuum test.
- The prototype outer pod had issues during the shipping test. We are continuing to identify the causes and implement corrective action as necessary for the commercial pod
- New commercial outer pods will begin testing this quarter. They will be available for EUV industry use by the end of 2009

Acknowledgement

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