MEDEA+ Efforts on Maskless Lithography

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Maskless Meeting

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MEDEA+ Program – Overview

- Medea+ Maskless Lithography Projects
- European Advisory Board on Maskless Lithographies
- Maskless Domains
- A Business Model for Maskless Lithography?
- Conclusion

Medea+ Projects

- ~50 projects running or completed (~20 new proposals submitted)
- ⇒ 22 Technology projects
- ⇒ 7 Lithography projects
- ⇒ 2 Maskless Lithography projects

MEDEA+ Projects on CP-ML2

- **T408 Mapper**
  - **Objective: C&F Mapper tool**
  - **Coordination: Mapper Lithography**
  - **Partners: Philips ETG, Philips Research, Philips Semiconductors, IMEC**
  - **Duration: 2003-2005**

- **T409 Projection-ML2**
  - **Objective: C&F of PML2 tool**
  - **Coordination: Leica Microsystems**
  - **Partners: IMS Nanofabrication, IMS Jena, FhG ISiT, FhG HHI, FhG IOF, CEA LETI, EQUIcon, IMS Chips, Infineon Technologies, STMicroelectronics, Philips Semiconductors**
  - **Duration: 2004-2006**

European Advisory Board for Maskless Lithographies

- **Membership: suppliers and users**
  - **ASML**
  - **Leica Microsystems**
  - **Mapper Lithography**
  - **Infineon Technologies**
  - **Philips Semiconductors**
  - **STMicroelectronics**
  - **MEDEA+**

European Advisory Board for Maskless Lithographies: Charter

- **Steering of European Maskless Lithography Program**
  - **Maskless Masterplan**
    - Provide benchmark for projects
    - Status review of maskless lithography program
    - Assessment of expectations & possibilities
  - **Business model update, mask cost structure**
    - Continue supplier-user exchange
  - **Coordination of activities within and between Maskless projects**
- **European maskless litho contact body**
  - **Contacts with other consortia**
  - **Press info (in cooperation with Medea+)**

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Maskless Lithography Masterplan

- **Benchmark MEDEA+ program**
  - **Tool capability (5-10 wph)**
  - **Concept design: potential > 1 wph**
  - **Potential tools for 2007**
  - **Target: 45 nm half pitch**
- **User requirements**
  - **Applications and expectations for maskless lithography**
  - **Distinguish:**
    - Device engineering (resolution driven)
    - Prototyping (cycle-time driven)
    - (Low) volume production (cost driven)

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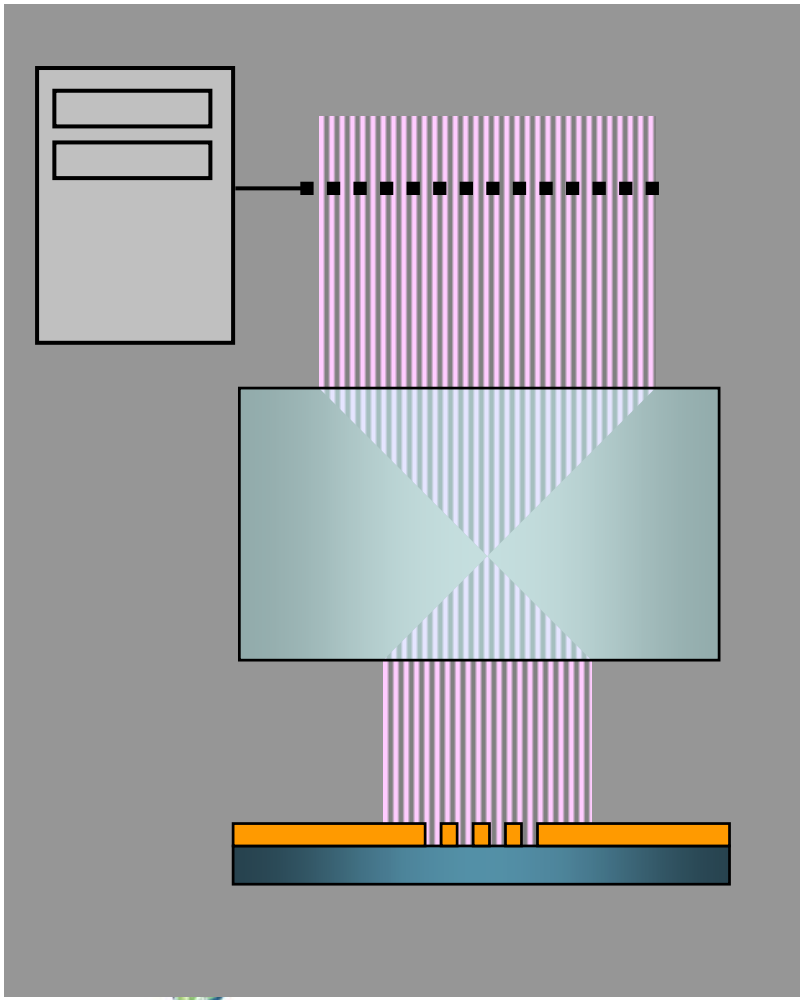
Maskless Lithographies: common features



- Optical or particle-based
- Multibeam (10 – 20,000)
- Beam modulation: deflection, scattering, blanking (MEMS technology)
- High data rate (>10 Gb/s)
- Various designs under development: Tools in 2007

Maskless Lithography Domains

A. Device engineering: *Resolution driven*
High-resolution patterning for advanced device architecture validation
R&D phase for technology node n+2 (i.e. 45 nm hp)

B. Prototyping: *Cycle-time driven*
Patterning for design validation of new products
After validation, volume production will start

C. Low volume production: *Cost-reduction driven*

All domains should allow mix and match with scanners

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Device Engineering

- **Throughput requirement: >0.2 wph**
  (capability for different wafer sizes: 200, 300 mm)
- **# critical levels: ~15 - >20**
- **Overlay accuracy:**
  23 nm @ 65 nm hp
  18 nm @ 45 nm hp
- **Design grid 5 nm for 65 nm**
  (1 nm OPC grid @ poly)

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Prototyping

- Throughput requirement: >5wph (300 mm)
- # critical levels: ~10-15
- Overlay accuracy:
  32 nm @ 90 nm hp
- # wafers per design verification: 35

Low Volume Production

- **Throughput requirement: > 10 wph (300 mm)**
- **# critical levels: <10**
- **Overlay accuracy:**
  35 nm (120 nm / 90 nm nodes)
- **# wafers/product: ~1500**

A Business Model for Maskless Lithography?

ML2 in the wafer fab

Compare:

- **Maskless Lithography (various concepts: A, B, C)**
- **E-beam direct write (EBDW)**
- **Mask-based: Multi-layer reticles (MLR)**

The wafer fab does not pay for masks!

→ ML2 is more expensive for the fab

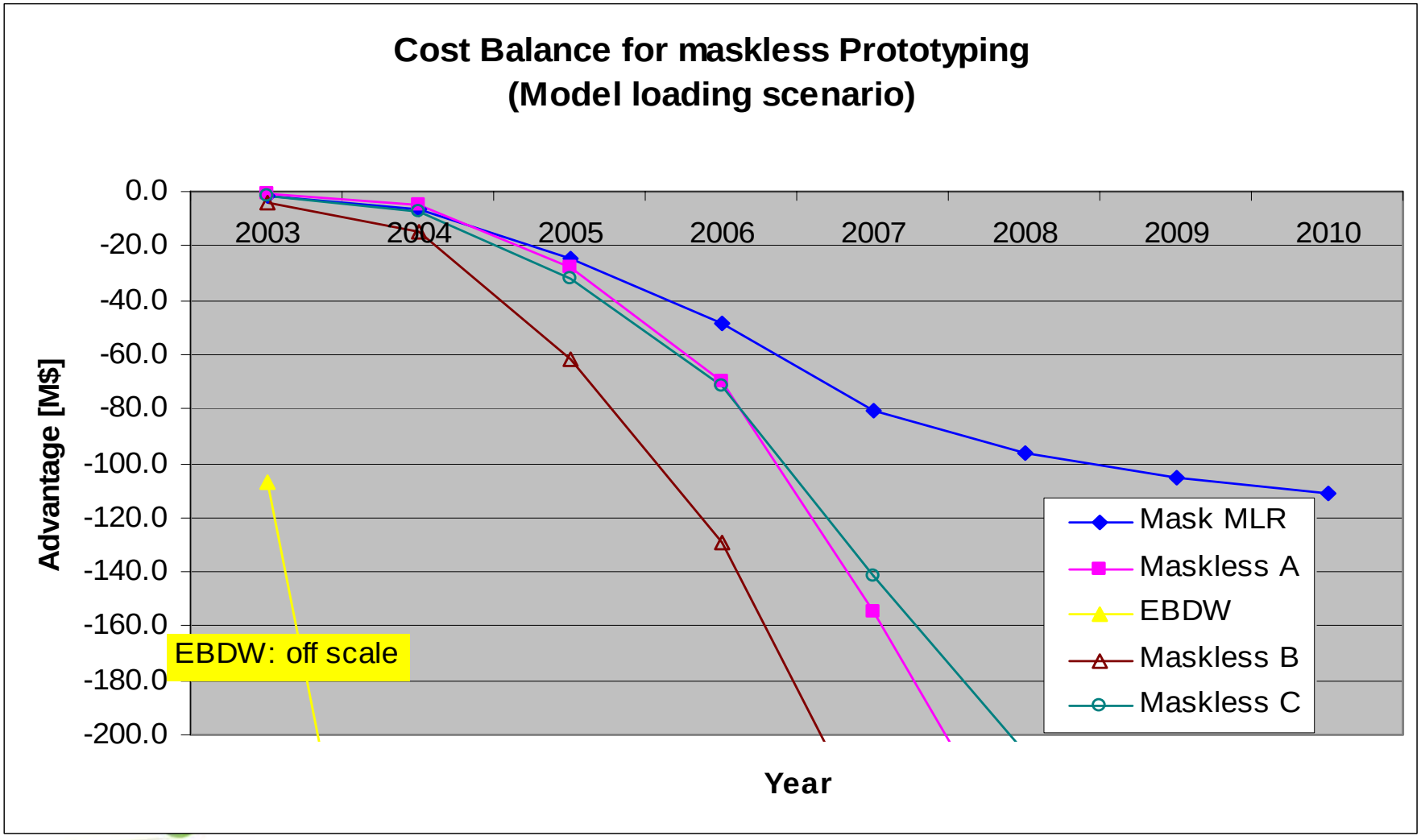
Business model for maskless lithography: inputs

- Benefit derives from low or no mask costs
- Cost is created by low throughput and dedicated tools
  - Depreciation of tool & associated track to be taken into account
  - Fab overhead: foot print area
- Prototyping characteristics
  - Success rate
  - Optical requalification costs
  - Mask respins
- Possible additional costs for maskless
  - Cost for different dataprep procedures for maskless?
  - Differences in chemicals/maintenance/operating costs per wafer
  - Additional CoO for two litho lines (prototyping & volume production in fab)
  - Optical maskless: match tool for mask-based imaging (193, 248 nm)

Differential CoO for Maskless Lithography Equipment Parameters

Item	MaskBased	Mask MLR	EBDW	Maskless A	Maskless B	Maskless C
Tool cost [M$]	25	25	10	25	10	15
Track cost [M$]	5	5	2	2	2	2
Depreciation time [yr]	5	5	5	5	5	5
Depreciation / year [M$/yr]	6	6	2.4	5.4	2.4	3.4
Floorspace Expo [m^2]	10	10	4	10	4	4
Floorspace Track [m^2]	12	12	8	8	8	8
Floorspace total [m^2]	22	22	12	18	12	12
Floorspace price [$/$m^2$]	5000	5000	5000	5000	5000	5000
Floorspace contribution/year [M$/yr]	0.11	0.11	0.06	0.09	0.06	0.06
Floorspace ratio w.r.t. mask	1.00	1.00	0.55	0.82	0.55	0.55
Nominal throughput [wph]	90	23	0.2	10	5	10
Uptime [%]	80	80	80	80	80	80
Utilization [%]	95	95	95	95	95	95

Is maskless lithography more cost-effective?



(Source: J.W. Gemmink)

Maskless lithography for prototyping: Preliminary conclusions

- **Maskless prototyping is not (yet) cost-effective for the fab**
  - **Impact on fab output cost is larger than gain by 'no mask cost'.**
  - **Throughput increase for maskless has only limited effect**
  - **From a cost/prototype perspective, use of multi-layer reticles (MLR) seems most attractive**
- **However, maskless lithography may shorten development time**
- **Flexibility – not cost reduction – is a primary driver for maskless lithography**