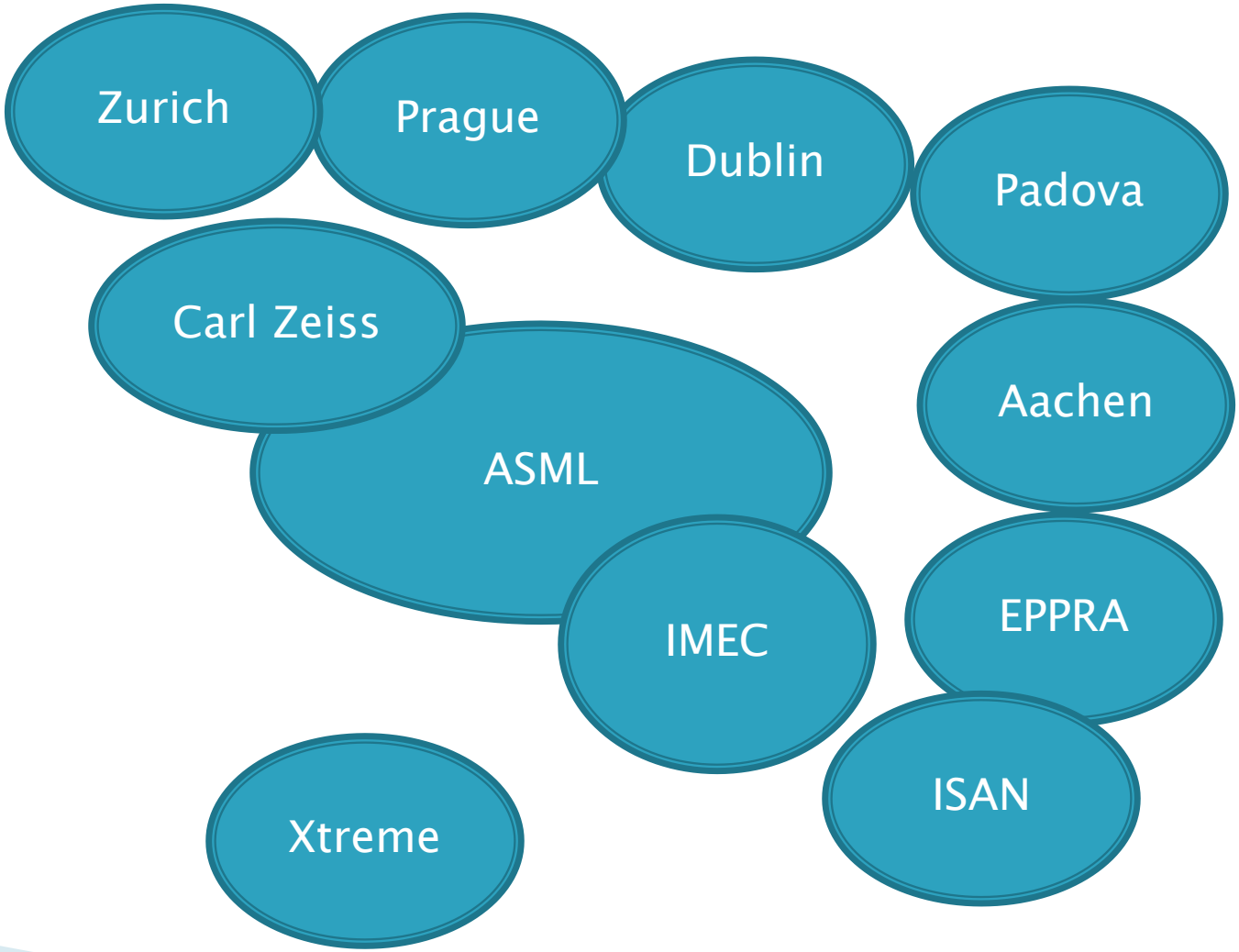
Panel Discussion - Europe.

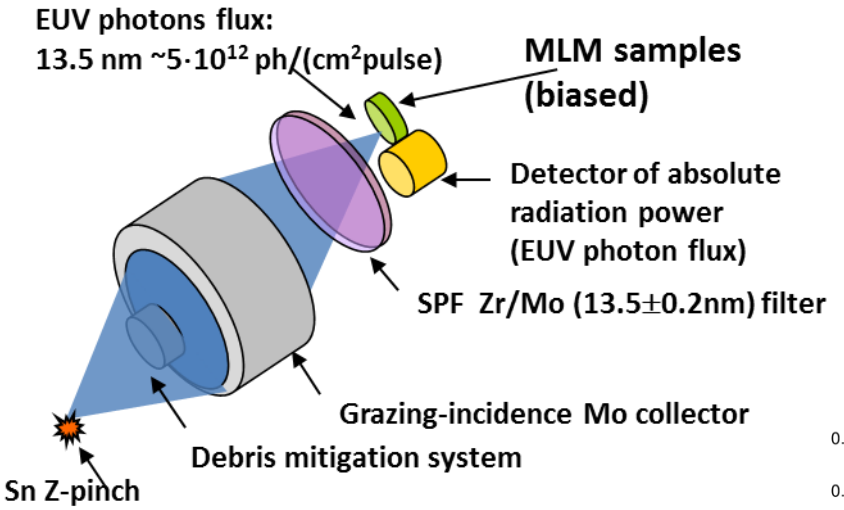
Padraig Dunne, UCD School of Physics
Dublin, Ireland.

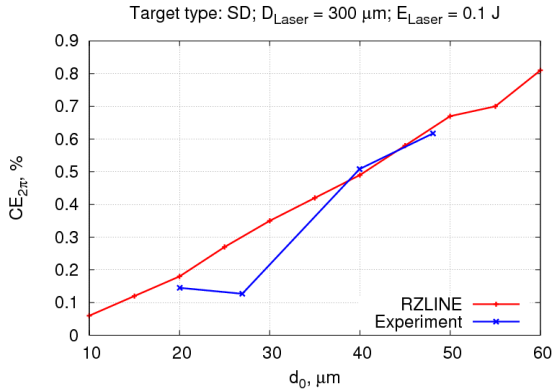
Contents

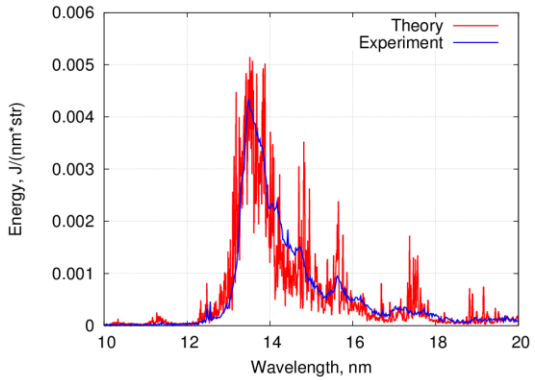

Zurich
Prague
Dublin
Padova
Carl Zeiss
Aachen
ASML
IMEC
EPPRA
ISAN
Xtreme

ISAN

Progress in “on line” MLM carbon cleaning



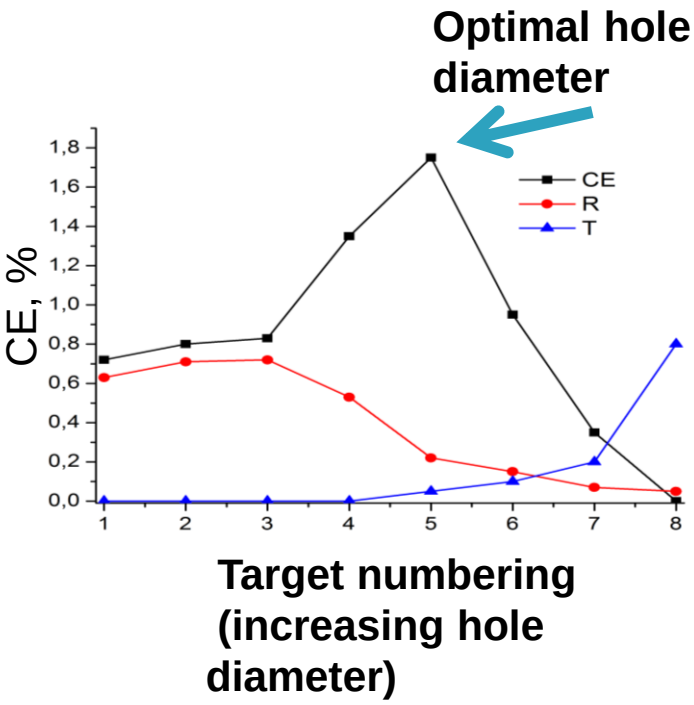


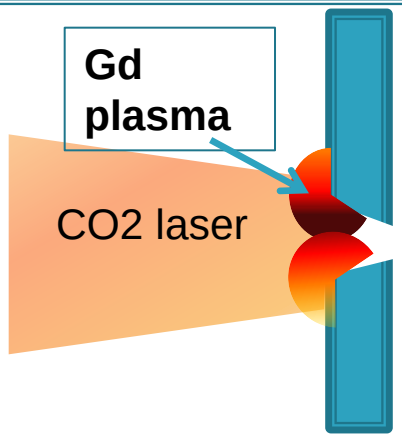


Progress in radiative hydrodynamics modeling of LPP EUV sources (I)

Progress in BEUV (6.X nm) source investigations

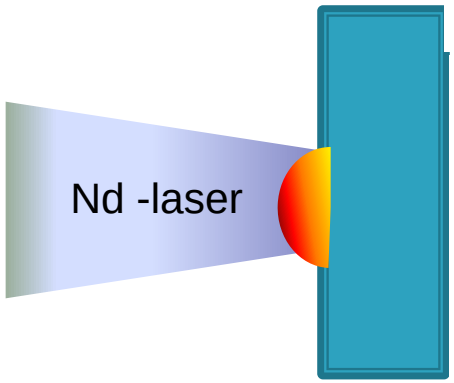
CE % (0.6% band),
T & R – transmission and reflectivity of plasma for CO2 laser radiation

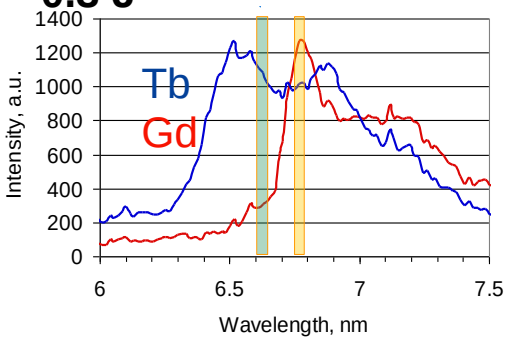




Target – Gd foil 80 μ thick

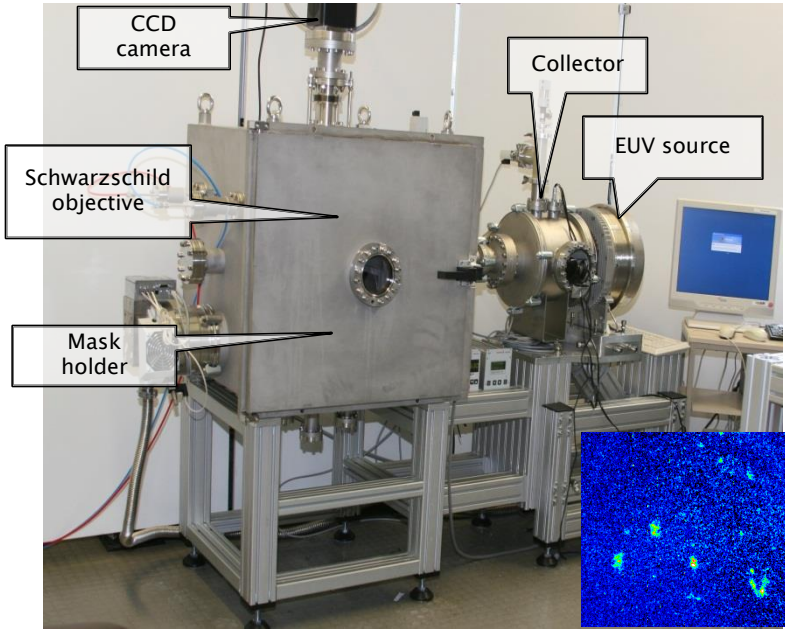
Laser energy 600 mJ
Laser spot dia. 300 μ
Pulse duration 100 ns
Power density ~10^{10} W/cm^2



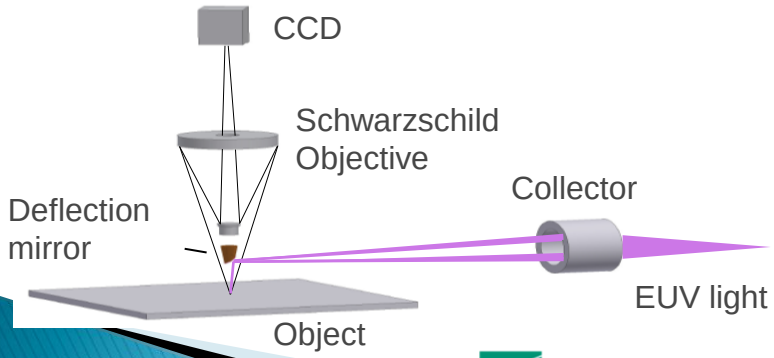


CO_2 laser - CE = 1.8 % for Gd has been demonstrated (0,6 % bandwidth).
Nd - laser; 1,2 ns, 0.3 J – CE = 1.05 % for Gd and Tb (0,6 % bandwidth)

Microscopy with extreme ultraviolet and soft x-ray radiation



Reflection dark field microscope for defect inspection of EUV mask blanks



- **high elemental contrast**
- **higher spatial resolution (20 nm) compared to light microscopy**
- **larger penetration depths (10 µm) compared to electron microscopes**
- **high throughput in dark field (scatter) mode**
- **with high sensitivity to small structures (down to 10 nm)**

Mask blank inspection:

- **Fundamental investigations into defect detection (influence of different kind of defects on signal)**
- **Fast scanning of large surfaces – with 1 µm resolution and 10 nm sensitivity**
- **Design rules for an industrial mask blank inspection tool (source, optical system, detector, interaction of EUV radiation with a defect)**

Fraunhofer ILT

TOS RWTH RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN LEHRSTUHL FÜR TECHNOLOGIE OPTISCHER SYSTEME

EUV RWTH RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN CHAIR FOR EXPERIMENTAL PHYSICS OF EXTREME ULTRAVIOLET

University of Padova

JOURNAL OF APPLIED PHYSICS **113**, 203106 (2013)

Damage of multilayer optics with varying capping layers induced by focused extreme ultraviolet beam

Alain Jody Corso,[1,2] Paola Zuppella,[1] Frank Barkusky,[3,4] Klaus Mann,[3] Matthias Müller,[3] Piergiorgio Nicolosi,[1,2] Marco Nardello,[1,2] and Maria Guglielmina Pelizzo[1,2]
[1]*National Research Council of Italy, Institute for Photonics and Nanotechnology, via Trasea 7, 35131 Padova, Italy*
[2]*Department of Information Engineering, University of Padova, via Gradenigo 6/B, 35131 Padova, Italy*
[3]*Laser-Laboratorium Göttingen e.V, Göttingen, Germany*
[4]*KLA-Tencor, 5 Technology Dr., Milpitas, California 95035, USA*

(Received 11 March 2013; accepted 9 May 2013; published online 28 May 2013)

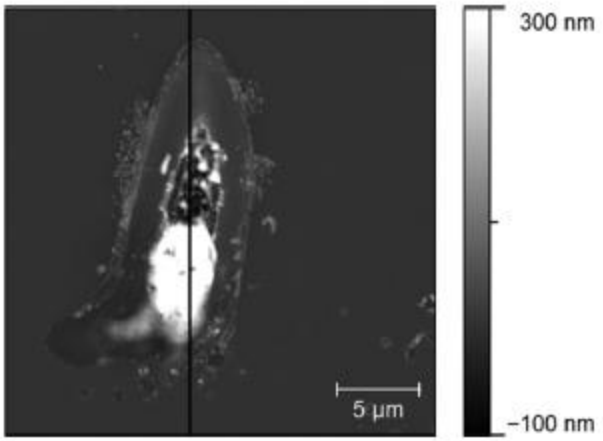


FIG. 5. CL2-D3, $F = 1720\,mJ/cm^2$ topography and depth profile.

EPPRA

EPPRA (France) together with partners from School of Physics of UCD (Ireland) and KIAM (Russia) continues to substantially redevelop the Z* code to Z+ in the framework of the EU FP7 IAPP project FIRE to include improved atomic physics models and full 3-D plasma simulation of radiative plasma dynamics of EUV & soft X-ray sources.

S. and V. ZAKHAROV with co-authors use improved Z* and Z+ codes:

- to study spectral properties and dynamics of LPP in UCD with different target materials and admixtures
- to examine physical properties of Laser Assisted Vacuum Arc in UCD with rotating electrodes in collaboration with TCD (Ireland) and RWTH Aachen University (Germany)
- to understand the stability issues of Laser Assisted DPP with rotating electrodes at TRINITI (Russia)
- to optimize the 80kA capillary discharge soft X-ray radiation source in water-window range with Institute of Plasma Physics and CTU in Prague (Czech)

NaexStream, a French company located near Paris, started development of high brightness sources in both EUV and soft X-Ray range, for metrology and mask inspection applications.

Dublin: UCD, TCD & DCU

- UCD
  - Colliding plasma work for 13.5 nm
  - Time-resolved spectra at 13.5 nm
  - Dilute high-Z targets for 13.5 nm
  - DPP studies at 13.5 nm

  - Time-resolved Gd spectra for 6.x nm
  - Ga & Ge studies for 6.x nm

  - New grant proposal in preparation……..
- TCD
  - DPP studies for 13.5 nm
- DCU
  - Colliding plasma characterisation

Zurich

- ETHZ – Laboratory for Energy Conversion (LEC)
- 6 years work on LPP sources
- New – ALPS II – tin droplet
  - Since March 2013 – new kW laser & droplet generator
  - Development from ALPS I
  - Brightness 259 W/mm^{2}sr
  - In-band EUV collectible of 5W demonstrated
- Adlyte is commercialising the source.

Prague

- Multiple Centres of Activity
- > 50 active researchers + ~20 students
- Optics, sources, applications
- Plasma diagnostics
- Universities, Institutes + RIT Europe
- See P53, Ladislav Pina.

ASML

ASML

Public
Slide 47

NXE:3300B shows single-digit (9 nm HP) patterning capability!

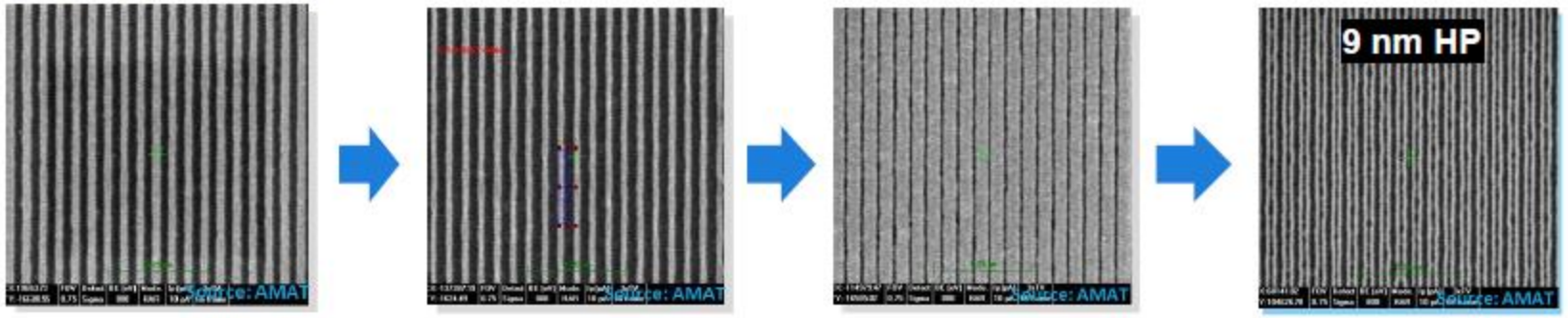
using spacer-assisted double patterning (SADP)

NXE litho
(single expose, 18nm HP)

Core etch

Spacer dep.

Spacer etch



Demonstrated 9 nm half-pitch L/S pattern with EUV single SADP flow.

Litho Conditions:

- ASML NXE:3300B system
- EUVL single expose 18nm HP
- 0.33NA, Dipole-90x illumination
- Resist: 50nm EUV J1099 on 20nm BS AL412 UL on stack wafer with Hard mask

Source: ASML, IMEC, AMAT (Feb.'13)

ASML

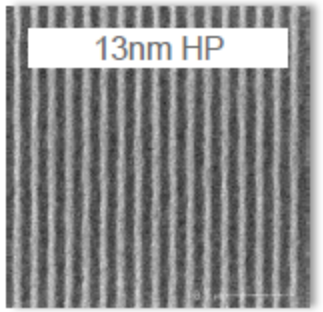
Summary

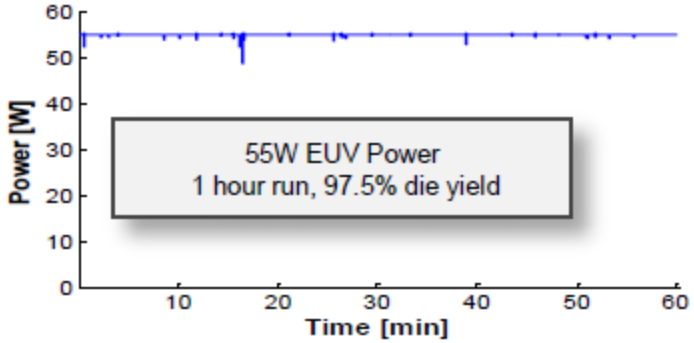
- **NXE:3100** in use for process and device development at customers
- **NXE:3300B** tested and qualified, 11 systems in various phases of integration
  - Overlay performance of DCO<2nm and MMO<4nm demonstrated
  - Good imaging performance for 1D (22nm to 16nm), 2D (Contact Holes and Metal 1) shown
  - Dose reduction to <16mJ/cm2 for 22nm achieved by utilizing contrast enhancement with off-axis illumination
  - Resolution of 13nm LS and 18nm Contact Holes demonstrated. Further process optimization to be done
  - 40W source power demonstrated with good dose control *and* under good collector protection conditions in six 1-hour runs, and 55W source power demonstrated in 1 hour run with good dose control and same collector protection conditions

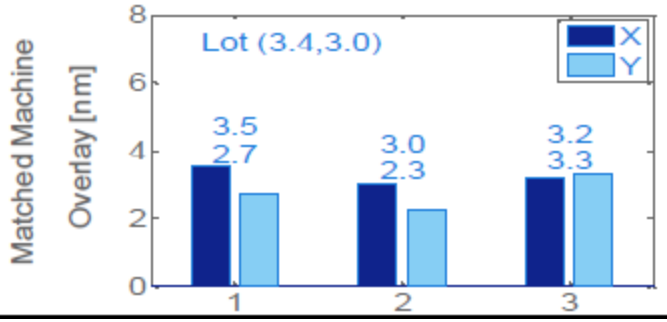
ASML

Public

Slide 49



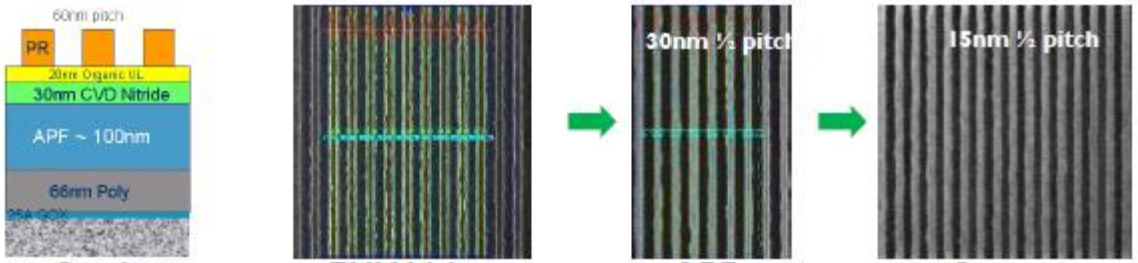




IMEC

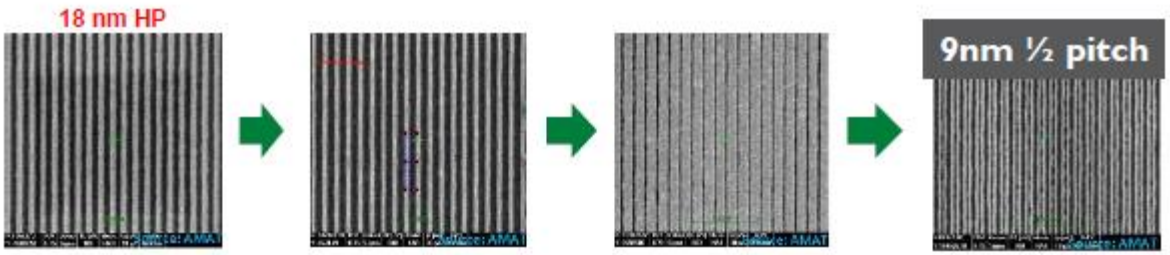
EUV EXTENDIBILITY
EUV LITHOGRAPHY + SADP

15 nm hp patterning demonstration enabled by NXE:3100 (NA 0.25) + SADP



Stack | EUV Litho | APF Mandrel | Spacer DPT

9 nm hp patterning demonstration enabled by NXE:3300 (NA 0.33) SADP



EUV Litho (0.33NA, dipole) | Core Etch | Spacer Dep | Spacer Etch

Xtreme Technologies

TOKYO--(BUSINESS WIRE)--USHIO INC. (Headquarters: Tokyo, Japan; President and Chief Executive Officer: Shiro Sugata; hereinafter "USHIO") (TOKYO:6925) today announced that it will close down the activities of XTREME technologies GmbH (Headquarters: Germany; President: Tatsushi Igarashi, hereinafter "XTREME"), a research and development company for Extreme Ultraviolet (EUV) light sources for next-generation semiconductor lithography, and consolidate the EUV light source business into a single unit in Japan and continue it for inspection and development applications in the future.

May 09, 2013 03:00 AM Eastern Daylight Time

Thank You