Accelerating the next technology revolution

2010 Resist TWG

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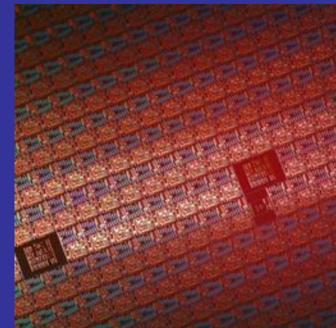

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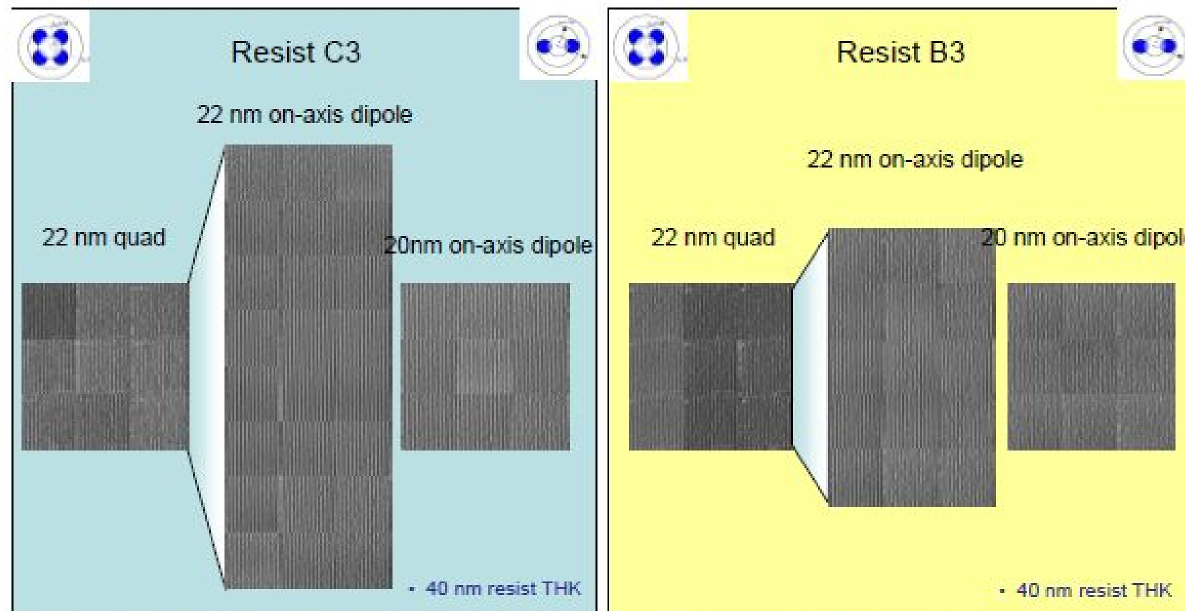
Resist TWG: Mission & Objective

- **Mission: Provide a forum for International EUV resist community to share non-confidential information on the progress, and key challenges in EUV resist development.**
  - Coordinate efforts to identify & address top issues
- **Objective: Provide forum to share information to foster global collaboration to accelerate development of EUV resists**

Patterning Fidelity of EUV Resists – On-axis Dipole

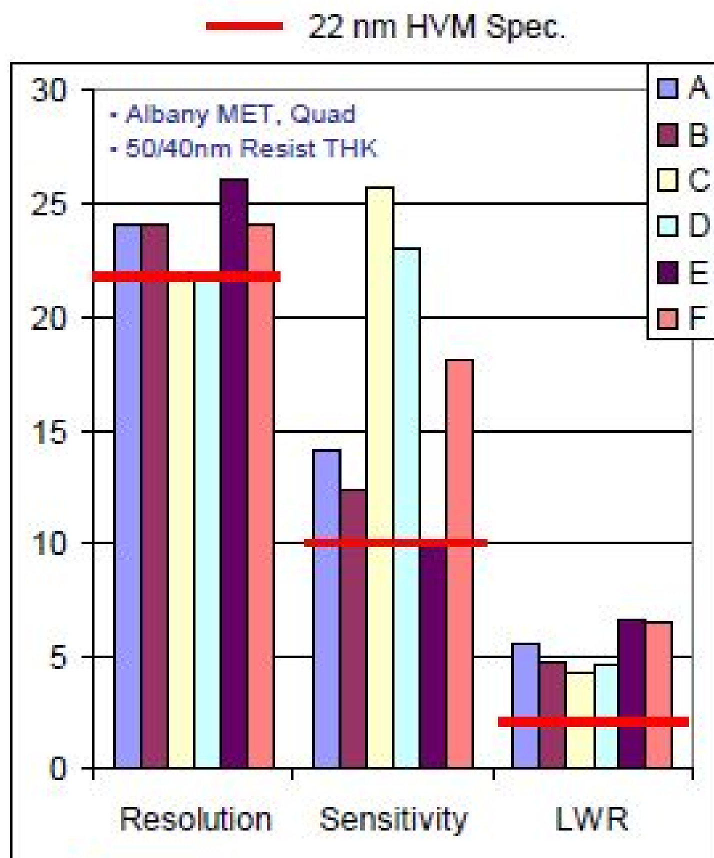


In general, on-axis dipole imaging capability has increased.

Introduction

- Resolution and Sensitivity are improving
  - Multiple resist vendors are now demonstrating **22-20nm hp** resolution with CAR on all EUV Micro Exposure Tools
- Pattern Collapse
  - Pattern collapse is a dominant issue limiting resolution for most EUV material platforms
  - Rinse materials aimed at capillary force reduction are not sufficient to entirely eliminate collapse
  - 2 additional factors are known to affect collapse behavior: swelling and adhesion
  - Need more work towards a total collapse solution
- LWR improvement
  - Current materials are far from the LWR target
    - Many materials at >4nm, target is <2nm
  - LWR improvement belongs to both litho and pattern transfer
    - Looking for an integrated solution to get to the target level
- Outgassing
  - Major issue limiting materials research and development
    - Test procedure is too expensive, too time consuming, and not readily available to the litho community

Key Gap for 22 nm Patterning

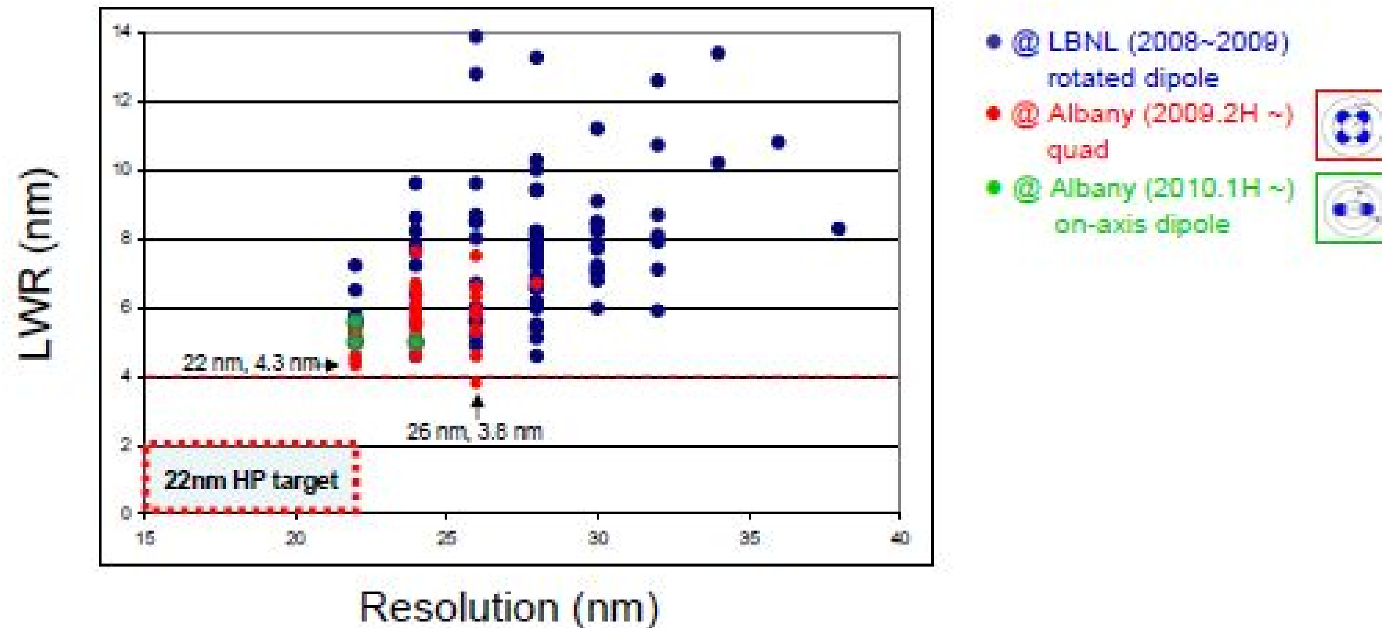


- Key Gaps for 22 nm HP Patterning

1. LWR
2. Collapse
3. Sensitivity
4. Resolution

5. Defect (bridge/scum)
6. Pattern transfer with thin resist

EUV Resist Performance Status



- Resolution moves downward and almost meets the 22 nm HP.
- For LER, there is a barrier around 4 nm that we need to break through.

- Using dipole, we can get a smaller pattern with same resist.

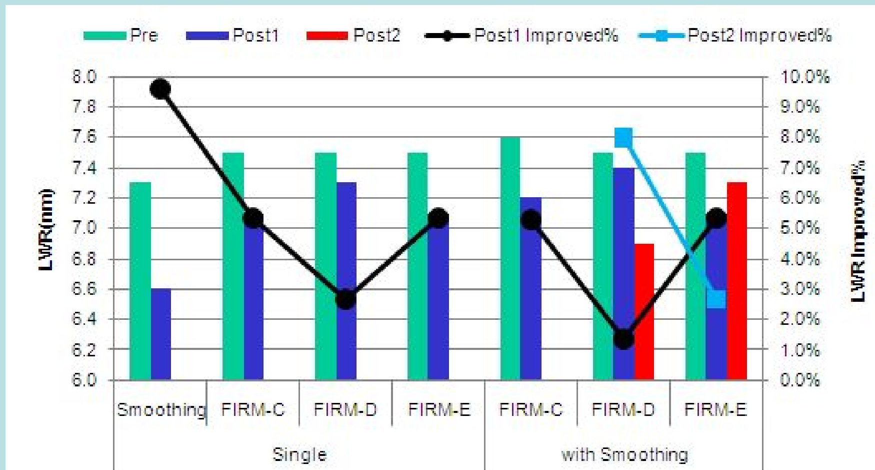
Track and Etch Based Improvements

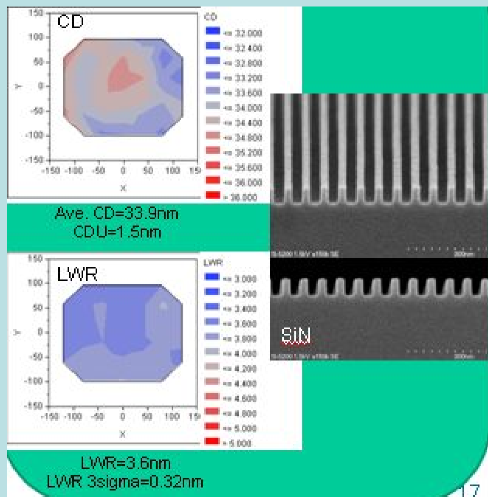
In 2010 we found:

- SEMATECH was one of the first organization to look at TBAH with rinse.
- 8% improvement with smoothing
- 15 – 20% improvement with etch, driving down to 3.6nm
- 13% improvement with FIRM/alternate developer combination, also improving collapse margin by 7 – 8nm

In 2011, RMDC plans further collaboration with material suppliers to improve rinse materials and etch

Track based smoothing can reduce LWR by 8%



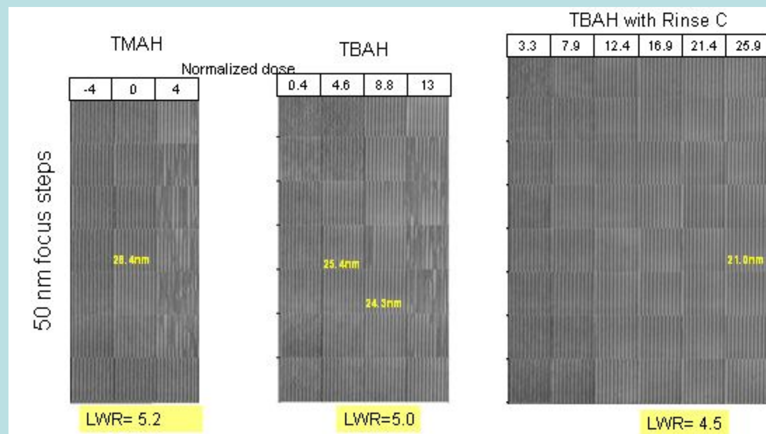


Etch Based LWR Reduction

16% LWR reduction through etch process

LWR 3.6nm achieved

Rinse processing reduces LWR by 13%



Resist TWG 22nm hp Status Update

Progress

- Several resist vendors are now demonstrating **22-20nm hp** resolution with CAR on all EUV Micro Exposure Tools
  - Good **22nm hp process windows at 40nm** resist thickness have been demonstrated on METs
  - Under-Layer/Resist stack optimization improving process windows and helping LWR
  - Resist sensitivity improving with **several ~10mJ/cm² resists** with good resolution (26nm hp demonstrated)
- RoX tool update
  - EUV RoX tool is being reconfigured to meet ASML's outgas testing requirements
  - Expected certification for ADT and NXT platforms before mid-year
  - In 2011 we expect to deliver 200 outgas tests to our members and associate members. This will be a combination of RGA and witness plates (Needed: 500-1000 actinic and e-beam tested samples per year)
- SEMATECH has engaged a commercial EUV tool supplier
  - Tool installation planned in 2011

Current Gaps

- **Pattern collapse reduction work needed for 22nm hp and below**
- LWR in resist only down to ~4.5nm at 22nm hp
- Post litho process combined with optimized pattern transfer work required to drive **LWR below 2nm**
- **Tools to measure outgassing meeting NXE specifications are becoming available**
  - Limited access
  - Inhibiting basic understanding of outgassing issues

Agenda

- Welcome and Introductions
- LWR
  - Tom Wallow: GF
  - Shinichiro Kawakami: TEL
  - Bang-Ching Ho: Nissan
- Outgassing
  - Greg Denbeaux: CNSE
  - Ivan Pollentier: IMEC
  - Charles Tarrio / Steven Grantham: NIST