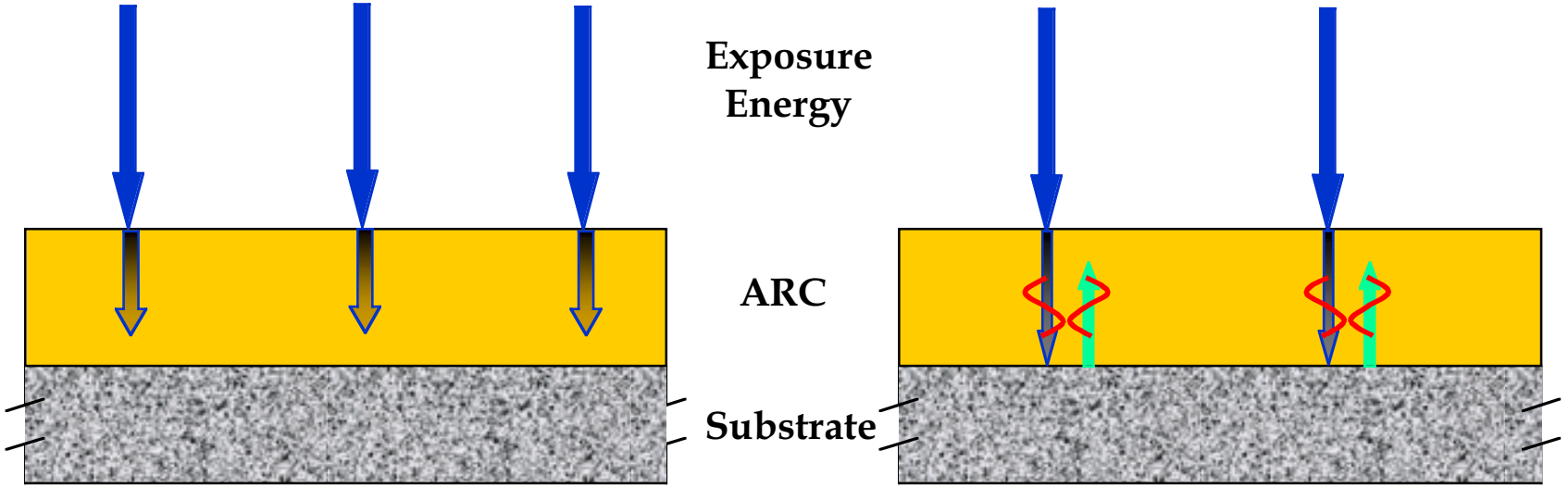
Understanding Brewer Science ARC® Products

Overview

- Anti-reflective coating introduction
- Types of anti-reflective coating
- Advantages to anti-reflective coatings
- Advantages to bottom anti-reflective coatings
- Guide to products and compatabilities

Anti-Reflective Coating Introduction

- Anti-reflective coatings (ARC® products) can do several things
  - Absorb light entering the material by light absorbing compounds in material.
  - If ARC® products is the correct thickness can cause destructive interference of reflected light.



Types of Anti-reflective Coatings

- Organic
  - Applied like a photoresist
  - Top anti-reflective coating (TARC)
    - Applied after the photoresist
    - Absorbs light to give little reflection at substrate/resist surface
  - Bottom anti-reflective coating (BARC)
    - Applied before the photoresist
    - Absorbs light and uses destructive interference to give little reflection at the resist/ARC interface
- Inorganic
  - Deposited on substrate in special deposition chamber

Organic and Inorganic ARC

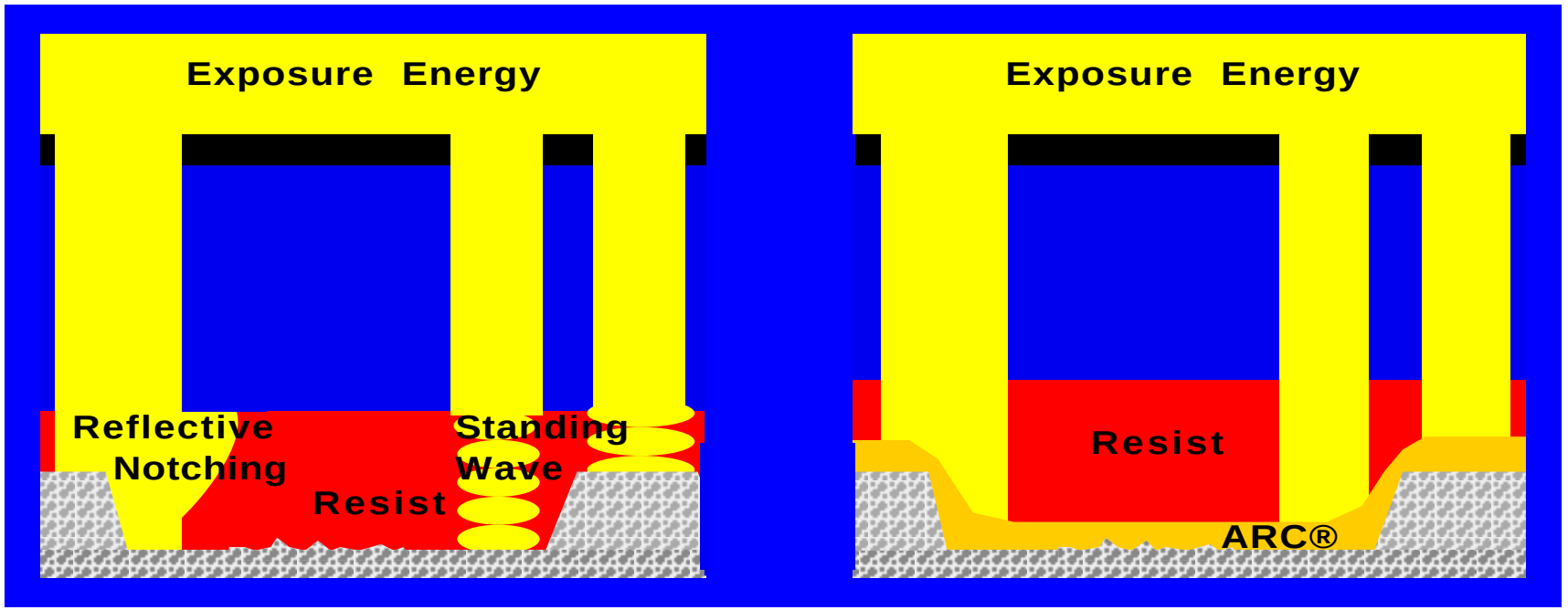
Property	Organic ARC	Inorganic ARC
Reflectivity and swing ratio reduction - 1st minimum	++	+++
Reflectivity and swing ratio reduction - 2nd and higher minima	+++	0
Etch rate	0 or +	+++
Coating conformity	0	++
Thickness tolerance	+	0
Plasma damage	+++	--
Refr. index reproducibility	+++	0
Throughput	++	+
Cost of Ownership	+	0
Stack issues	+++	-
Planarization capability	++	--
Rework capability	+++	--

Advantages of Anti-Reflective Coatings

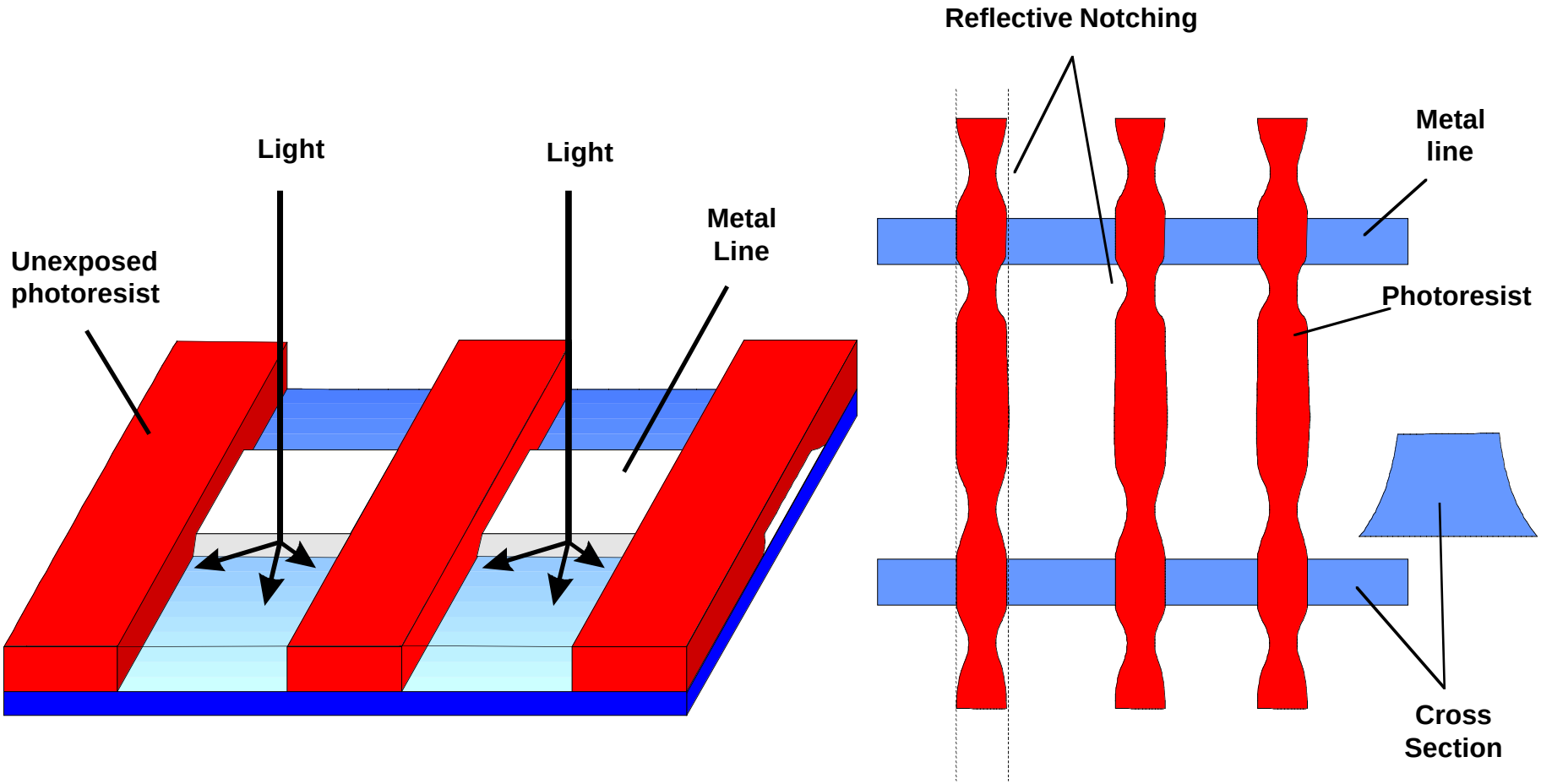
- Eliminates swing effect and standing waves in photoresist
- Solves topography related lithography problems
- Provides ultimate critical dimension (CD) control
- Expands process capability

Topography Related Lithography Problems

- Light reflecting off underlying substrate reduced or eliminated
  - Backscattering
  - Reflective notching
  - Standing Waves

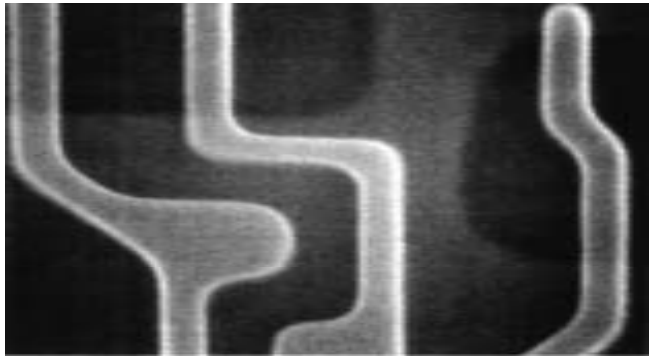


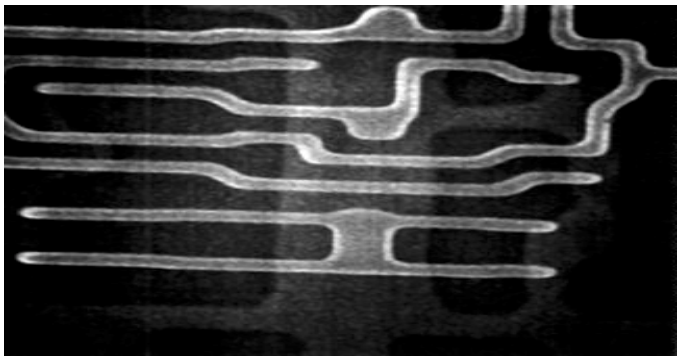
Reflective Notching



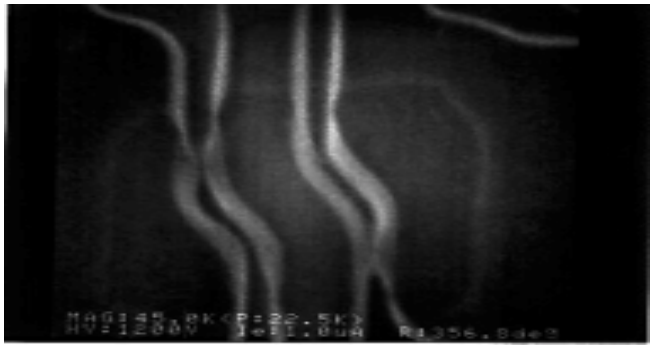
Reflective Notching

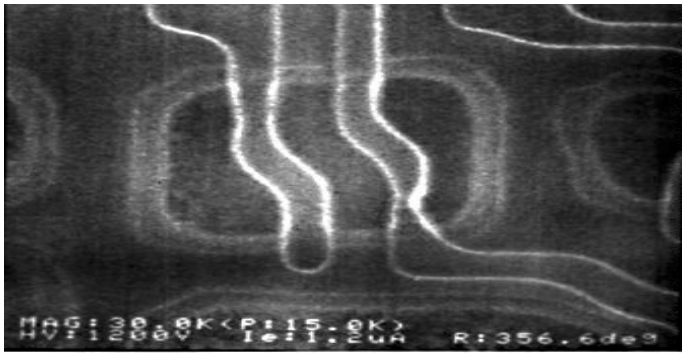
0.4µm on 2500Å steps using 1844Å XHRi





Competitor BARC

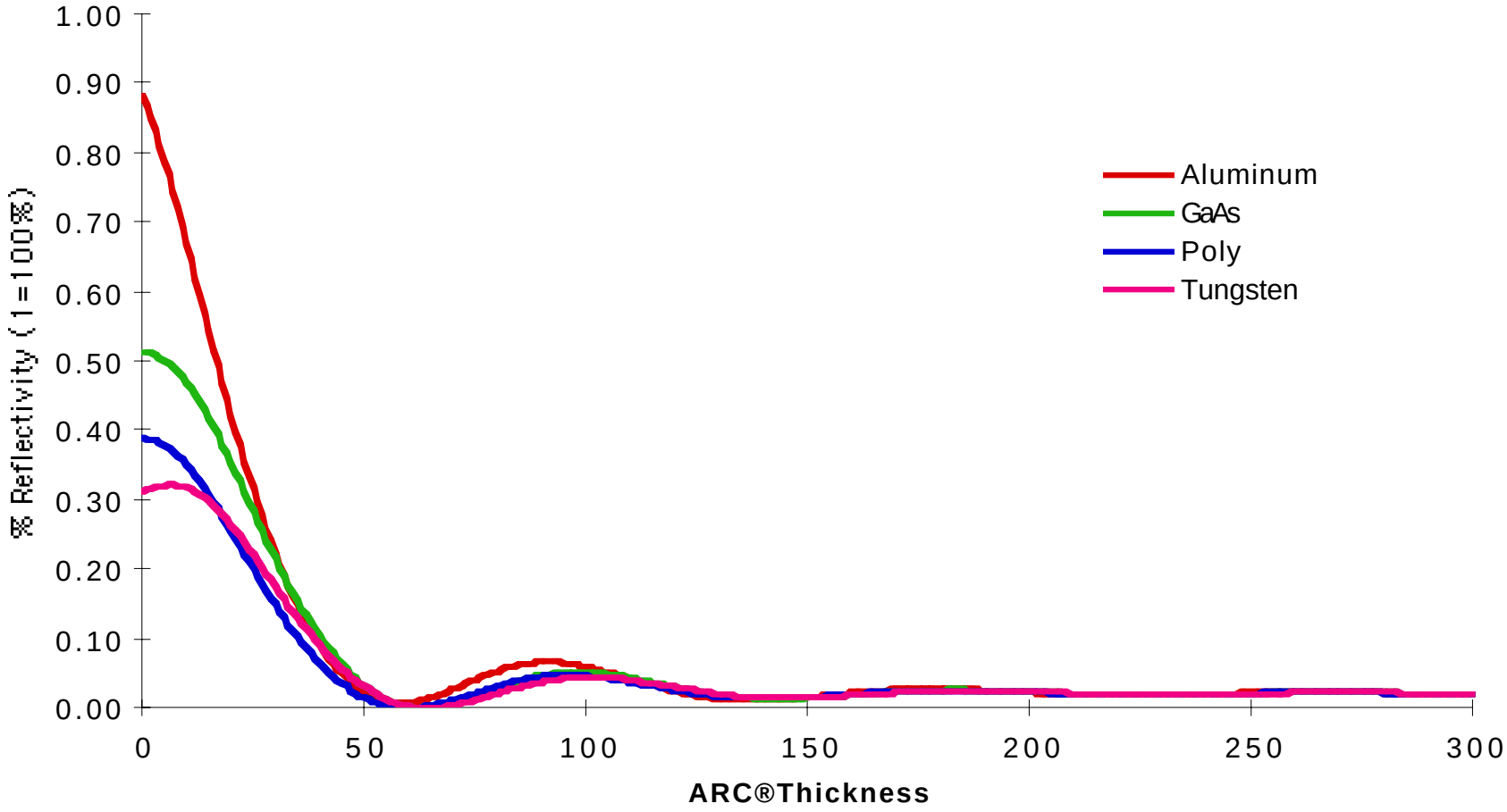




Swing Effects

- Dose to clear swing curve defined as the amount of light required to completely expose photoresist
- Swing curves reduced with application of ARC® products.

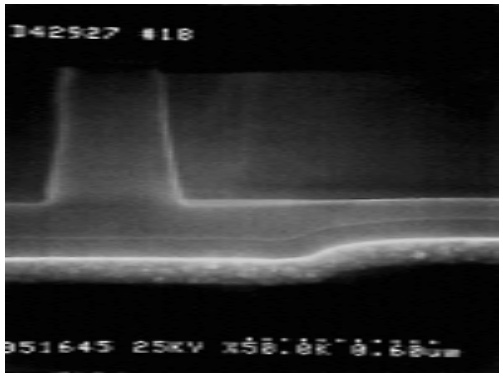
ARC® Products Reflectivity Curve

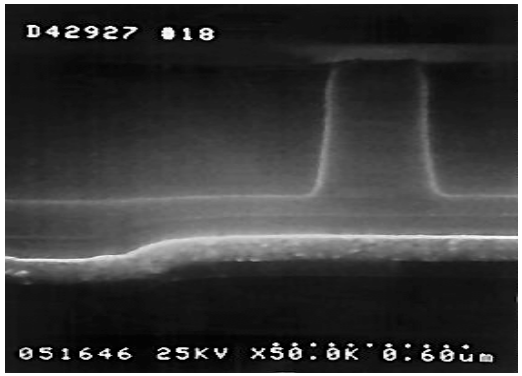


Resist Profiles on Topography

0.4µm with 2500Å Steps with 1844Å ARC XHRi

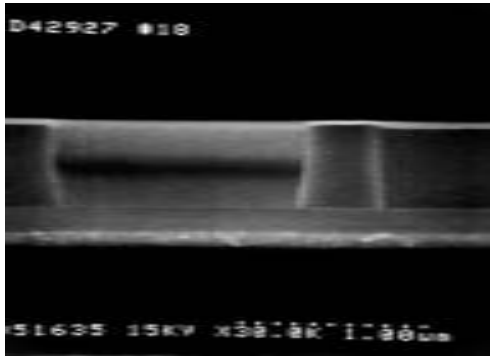
Low Area

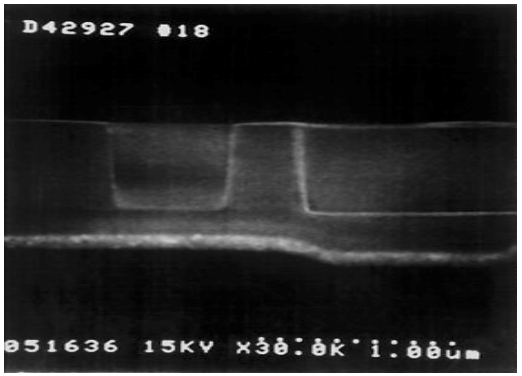




High Area

Flat Area





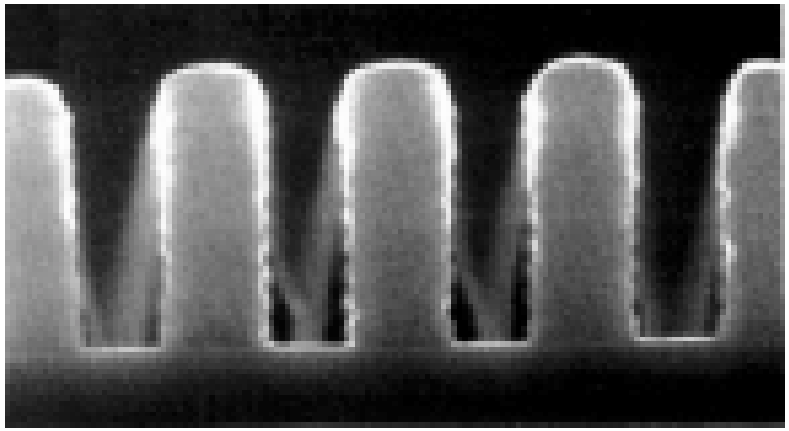
Transition

Advantages of organic ARC® Products

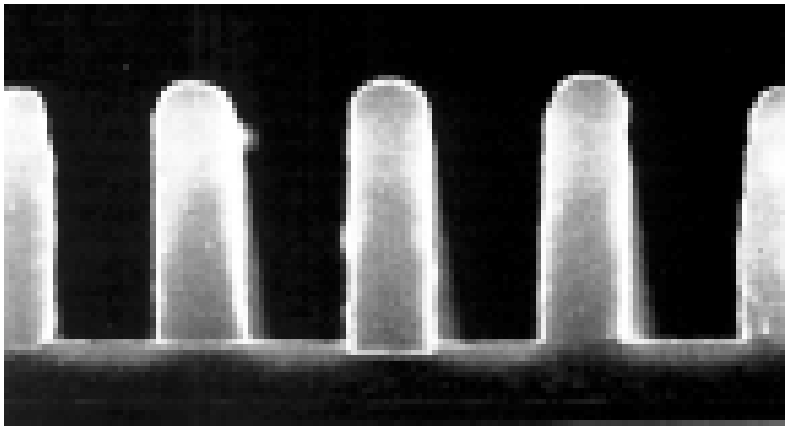
- Can apply with existing photoresist application systems
- Do not need expensive deposition chambers
- Prevents chemical interaction between photoresist and substrate
  - ARC ® products acts as wall to nitrogen poisoning with chemically amplified photoresists
- Increases CD control
  - Eliminates reflective notching
  - Eliminates standing waves and scattered light
- Extends lithography process window
  - Increases stepper focus latitude
  - Maximizes photoresist exposure latitude
  - Increases usage life of stepper.

Lines With or Without ARC® Products

PEK-103 0.20µm L/S



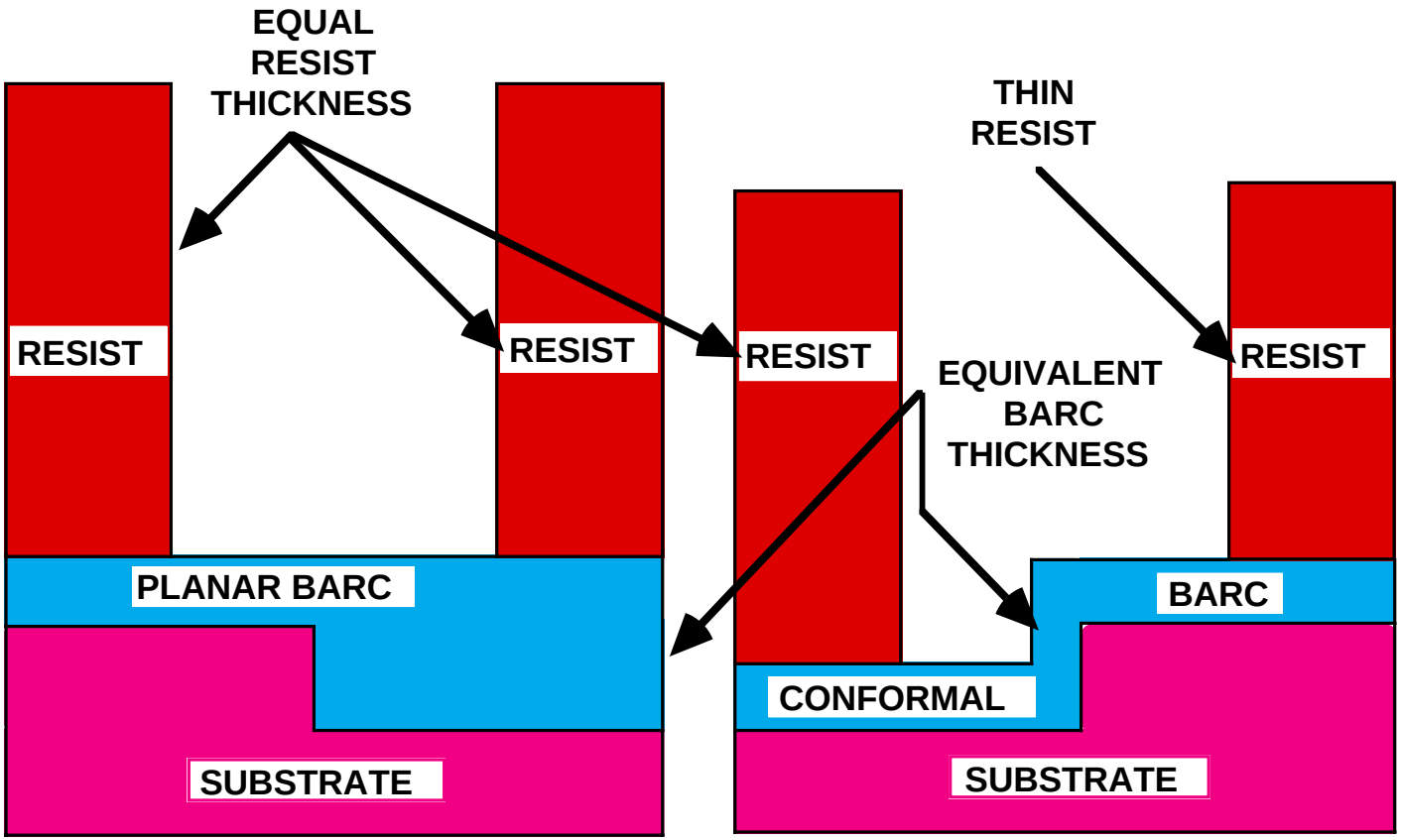
Resist on DUV42



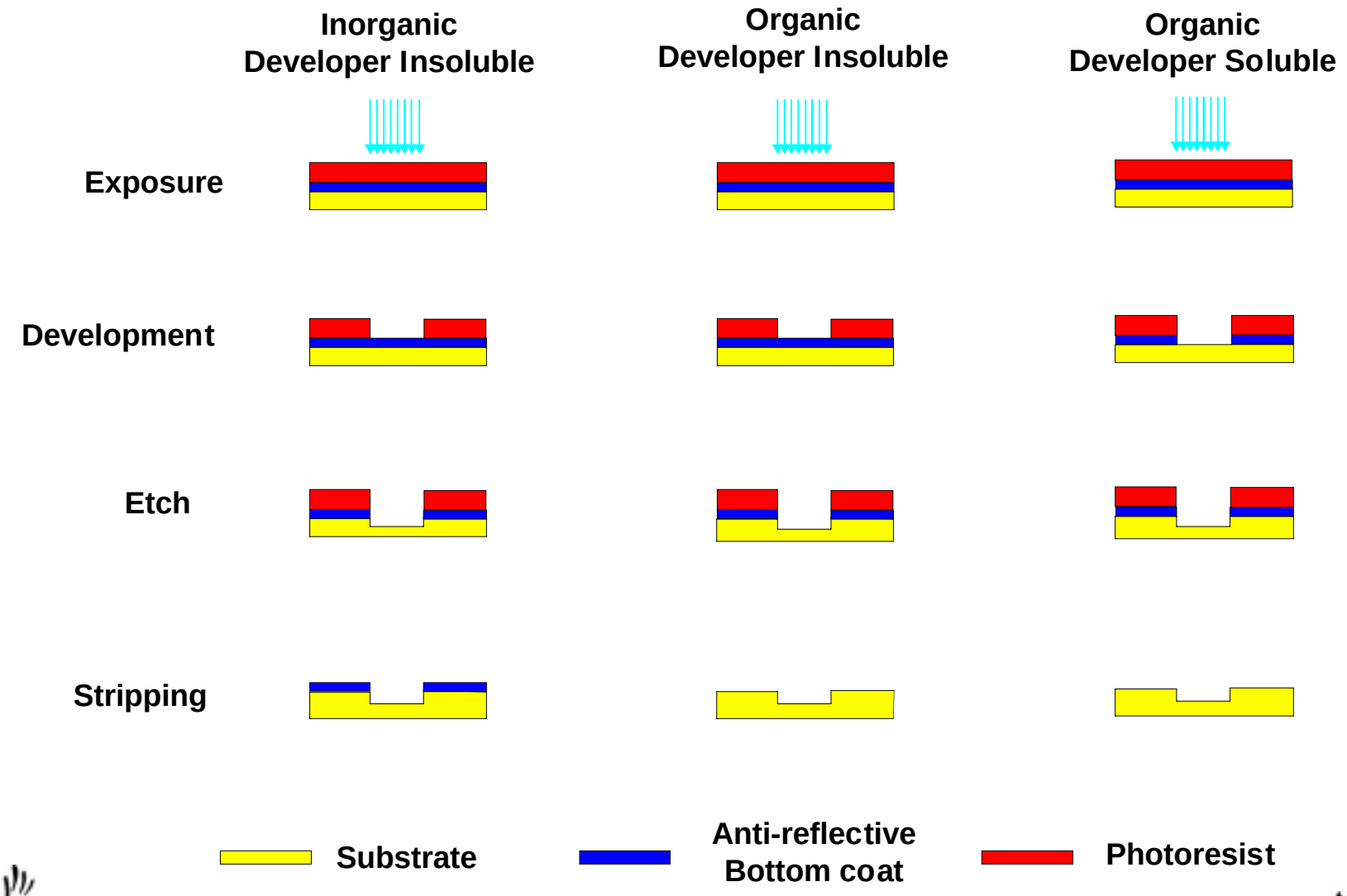
Guide to BSI ARC® Products

- Exposure wavelength
  - G-line, I-line, DUV, 193nm
- Planar or conformal ARC® products
  - Worst case step height
  - CD tolerances needed
- Wet or dry processing
  - Depending on equipment availability, CD and wavelength
  - Wet process BARC develops away with resist
  - Dry process BARC requires a gas etcher
- Choose BARC based on resist chosen
  - DUV resists have two chemistries
    - ACETAL
    - ESCAP/TBOC

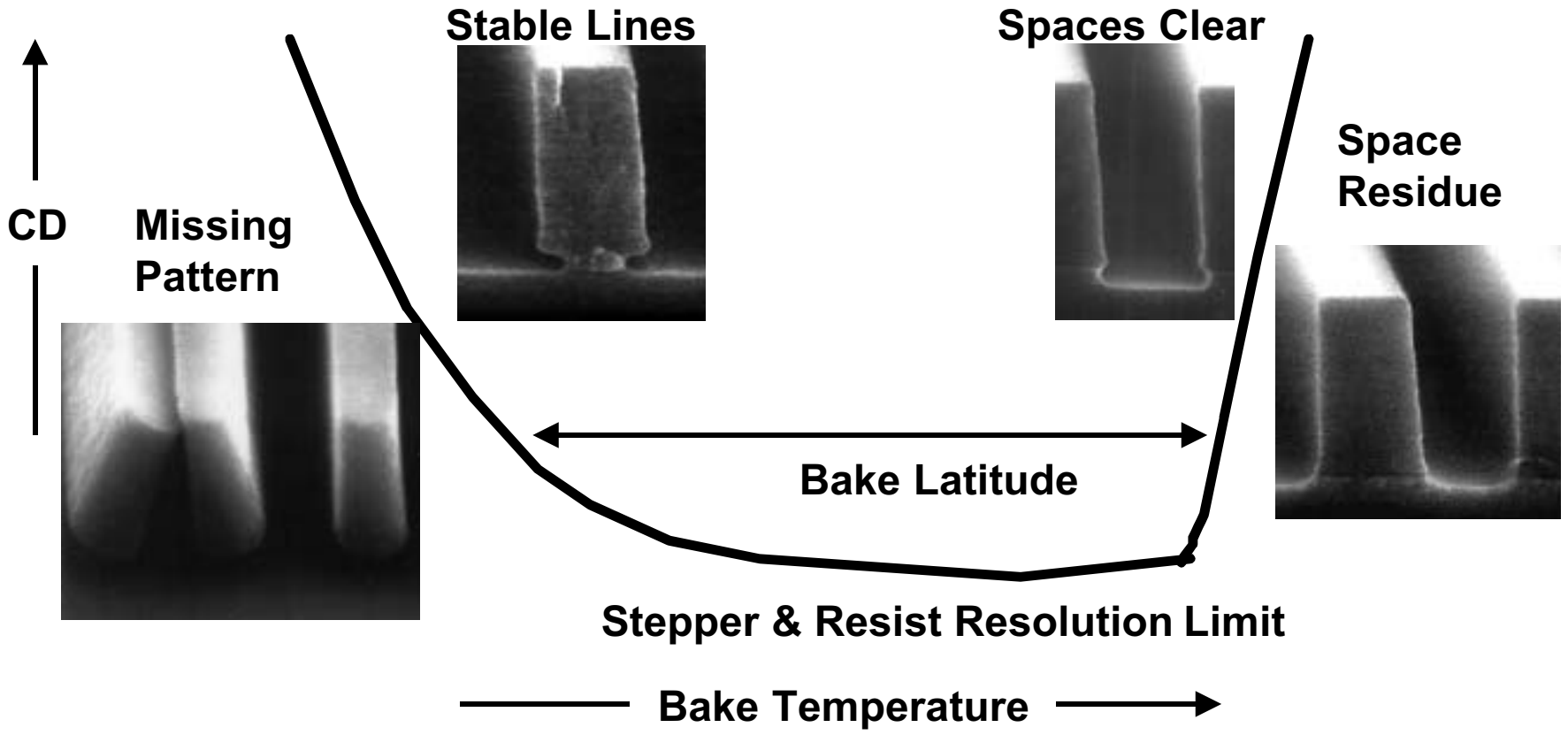
Planar vs Conformal ARC® Products



Wet or Dry Etch Processing

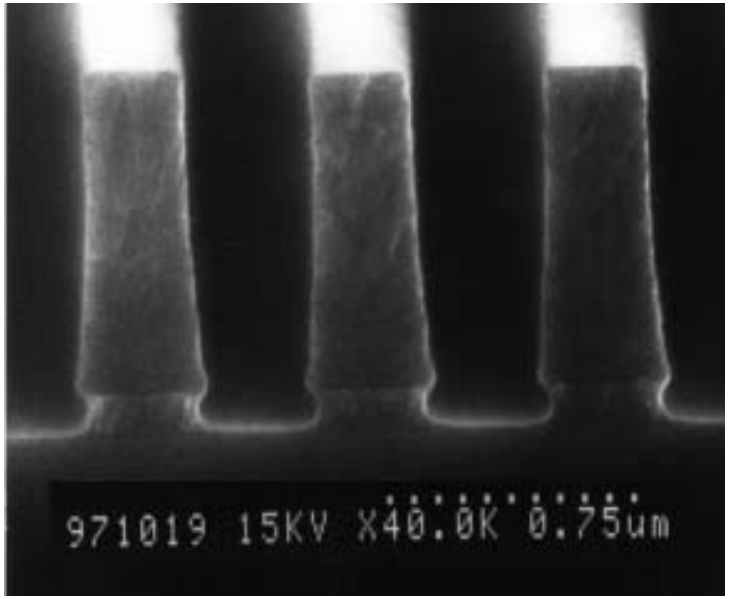


What is a Bake Window?

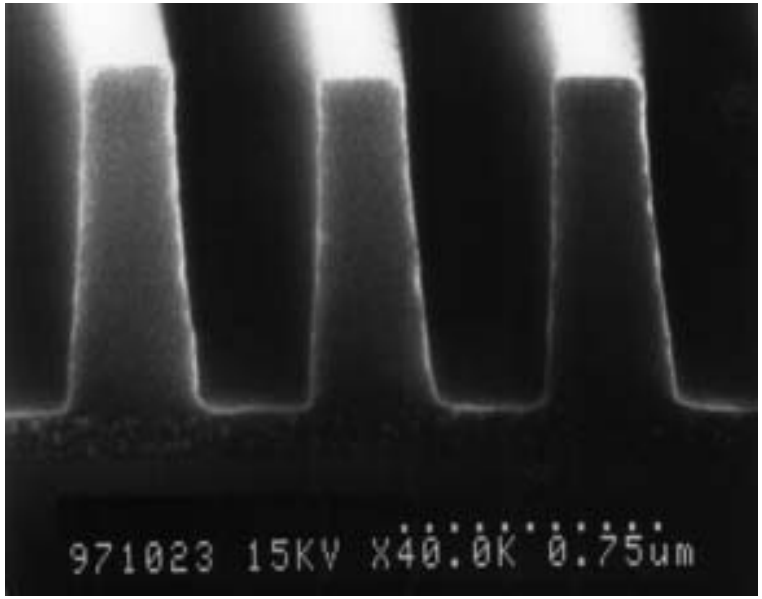


Wet or Dry Etch Patterning

0.35 µm Dense Lines



177°C Bake



205°C Bake

BSI ARC® Product Families

- G-line (broadband material)
  - Wet or dry process
    - XLT
    - XLX
- I-line
  - Wet or dry process
    - WiDE
  - Dry process only
    - XHRi
    - XHRiA

- DUV
  - Dry Process Only
  - ESCAP/TBOC compatible
    - DUV30 (planar)
    - DUV42 (conformal)
  - ACETAL compatible
    - DUV32 (planar)
    - DUV44 (conformal)

Planar ARC® products gives superior photo performance
Conformal ARC ® products gives superior etch performance

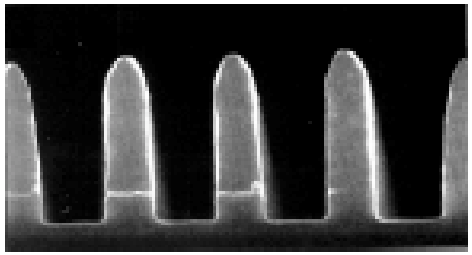
Various viscosities available in each family

Etch Capabilities

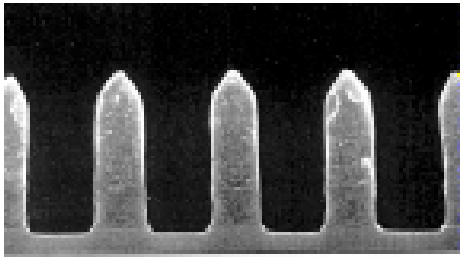
- Successfully dry etched in various chemistries
  - HBr
  - O_2
  - Cl_2, HCl
  - CF_4, C_2F_2
  - N_2
  - Carrier gases: He, Ar

DUV42 Etch Performance

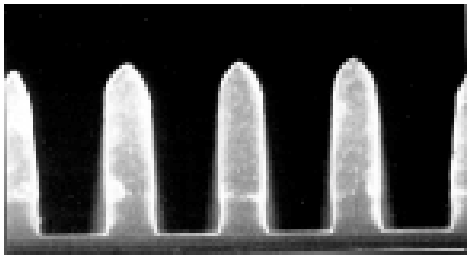
After He/O_2 etch.
ΔCD = 0.024µm.
Selectivity = 1.04



After Cl_2/O_2 etch.
ΔCD = 0.013µm.
Selectivity = 1.48



After HBr/O_2 etch.
ΔCD = 0.026µm.
Selectivity = 0.85



Cleaning/Stripping Capability

- ARC® products can be removed by common photoresist stripping processes
  - Oxidizing plasma or oxidizing solvent strip processes
    - Ozone Plasma Strip
    - O_2 Plasma
    - Piranha
    - RCA Clean