Addressing the Rising Challenges of Semiconductor Manufacturing

Taiwan-China Semiconductor Industry Outlook 2004

Rick Wallace
Rising Process Challenges

Rising Manufacturing Complexity
(subsmaller process window, design defects)

Innovation Driving Performance
(lower sampling, faster learning rate)

- Subwavelength Lithography
  - 248nm
  - 193nm
  - 157nm

- Wave length
- Line width

- Typical Process Steps
- Mask Levels

- Defect Density (D/cm²)

- Relative Gain in Performance

- TECHNOLOGY NODE
  - 100
  - 900
  - 800
  - 700
  - 600
  - 500
  - 400
  - 300
  - 200
  - 100

- NODE (nm)
  - 220
  - 130
  - 90
  - 65

- TIME
  - 1980
  - 1985
  - 1990
  - 1995
  - 2000
  - 2005
  - 2010

- Node
  - 365nm
  - 350nm
  - 248nm
  - 180nm
  - 130nm
  - 90nm
  - 65nm
  - 45nm

- Mask Levels
  - 625
  - 650
  - 685
  - 825
  - 900

- Mask Levels
  - 250
  - 180
  - 135
  - 90
  - 65
Rising Economic Challenges

Rising Fab Costs

- Costs in $M

Rising Mask Costs

- Costs in $K

Time to Market

- PC: 7 Years
- Play-Station 1: 10 Months
- Play-Station 2: 2 Days
- Market Windows Collapsing

Faster Yield Learning

- Prod $ Gain
- Ramp $ Gain
- Dev'l $ Gain

Cumulative Revenue Gain

- MONTHS: 0, 6, 12, 18, 24, 30, 36, 42, 48, 54, 60
The Evolving Role of Process Control

- Enabling Moore’s Law
  - 300mm / 0.13 um / Cu

- Enabling Device Scaling
  - < 0.5 um Line Monitoring

- Enabling Automation
  - < 1 um - Engineering Analysis

Source: Gartner / KLA-Tencor
Historical Perspective on the Role of Process Control
Japan – 1980’s – < 1 um

- Drove introduction of automated Inspection
- Focus on “continuous improvement”
- First to have dedicated yield management teams
Korea – 1990’s – 0.5 um

- Drove “in-line monitor” wafer inspection
- Focus on yield ramp - fast learning
- First to have mass production inspection
Taiwan – 2000 – 0.25 um

- Drove “high-mix” inspection strategies
- Focus on “speed” and “control”
- Large investment in process control
China

China – 2000 - present
- Not focused on leading edge design rule
- Yield Management has not been a priority
- Low relative investment in process control
Conclusion

- Increasing process complexity
- Increasing economic challenges
- Taiwan’s focus: “speed” and “control”
- China’s focus: “low cost”