Redefining Atomic Layer Deposition (ALD)

July 13, 2015
# Mobility and Connectivity Drive Performance Gains

**Increasing Functionality Driving the Biggest Semiconductor Inflections in Decades**

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**Sources:** Gartner  
* Average Mobile DRAM and NAND Content Per Unit of Premium Smartphone

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**Increasing Functionality Driving the Biggest Semiconductor Inflections in Decades**

[External Use]
Device Scaling Enabled by 3D Inflections

Transistor

- 3D FinFET Reduces Power Consumption

Memory

- 3D NAND Increases Storage Density

3D Topography Driving Increase in ALD Applications – $1B by 2016
3D Inflections Driving ALD Market Growth

3D FinFET
Tighter thickness/conformality control
Decreasing thermal budgets

3D NAND
Higher aspect ratios
Vertical, electrical grade films

3D Inflections Driving new Materials
High-Performance ALD required

New 3D Devices will Dominate Market by 2016
Applied Extends Leadership in Film Deposition

CVD
>25 years of leadership
6000 systems

PVD
>20 years of leadership
5000 systems

Epitaxy
Decade of leadership
900 systems

NEW
High-Performance
ALD Platform
Introducing the Applied Olympia™ ALD System for High-Performance Atomic Layer Deposition

- Innovative design delivers high-quality, low-temperature films required for 10nm
- Flexible process sequencing broadens spectrum of achievable ALD materials
- Proprietary chemical confinement delivers superior defect management
- Up to 4X higher productivity
Olympia Reconfigures ALD

**What is ALD?**

Divides CVD into **two** half-reactions

Is **self-limiting**, producing uniform, conformal deposition

**Conventional ALD**

- Wafer is stationary
- Alternating chemistries
- Purge separates chemistries

**Olympia ALD**

- Wafer travels continuously
- Spatially separated chemistries
- Chemistry-free zones isolate individual chemistries

Primary technology used today
Innovative Design

- Modular delivery establishes chemical zones
- Purge Elimination enables high productivity
- Chemical Confinement delivers superior defect management
Modular Design for Atomic-Level Engineering

ALD Mode

- Conventional ALD
- Plasma Enhanced
- Thermal
- Olympia ALD

Process Sequence

- A → B
- A → B → P
- A → B → X

Versatility Broadens Spectrum of Achievable ALD Materials without Compromising Productivity

Source: Applied Materials, Inc.
Olympia Differentiation Enables 10nm

Industry Challenge

Thermal Budget

- 45 nm
- 28 nm
- 20 nm
- 14 nm
- 10 nm
- 7 nm

Film Quality

- Conventional ALD
- Impurities Jeopardize Quality

Olympia Solution

- 14nm
- 10nm
- 7nm
- Olympia ALD

Unique ALD Sequence Preserves Film Quality at Low Temperatures
Modular Adaptability for Next-Generation Materials

Olympia ALD Modes

- Post-Treated
  - A → B → X

- Pre-Treated
  - A → X → B

- Multi-Chemical
  - A → B → C

- Multi-Chemical/Treatments
  - A → B → C → X

Olympia ALD

- Low-Temperature Films
- Advanced Patterning Films
- Selective Deposition
- Nano-Laminates
- Higher-k Films
- Lower-k Films

Opens the Way to Widest Spectrum of Achievable Next-Generation Films
Superior Capability with Uncompromised Productivity

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<th>Conventional ALD</th>
<th>Olympia ALD</th>
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<td><img src="image1" alt="Conventional ALD" /></td>
<td><img src="image2" alt="Olympia ALD" /></td>
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- **Long process overheads**
  - Low throughput
- **Exposure to both chemistries**
  - Greater risk of defects
- **Removal of purge increases throughput**
  - >50% shorter deposition time
- **Chemical isolation eliminates mixing of chemistries**
  - Superior defect control

Olympia Improves Productivity by Up to 4X
Applied Olympia™ ALD System
Paradigm Shift in Atomic Layer Deposition

- High-quality, low-temperature films for ≤10nm
- Modularity for materials engineering of future ALD films
- Unique chemical confinement to minimize defects
- High-productivity platform
- Proven differentiation - DTOR at multiple customer sites