Legacy & Leading Edge
Both are Winners

Techcet CMP Consumables
2015 Market Update

Semicon CMP User Group July 16, 2015

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Outline

- Semiconductor Outlook
- 2015 CMP Research Themes
- CMP Market
- Wrap Up
Semiconductor Outlook

Innovation is Alive & Well

New York Times, IBM Research
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Semiconductor Outlook

Mobile Market Continues to Evolve

• Mobile - Key IC growth driver
• Emerging Markets driving smart phone market
• Mobile July 2015 Mobile forecast (units shipped):
  • All mobile up 1.5%
  • Smartphones up 3.3%
  • Ultramobiles down 5.3%
  • Tablets decrease 5.9%
  • PC’s down >5%
• SSD market will continue to grow
  • Key driver – cloud computing
  • Key challenge – cost

Source: Gartner
SSD Forecast

Source: IHS
Semiconductor Outlook

Demand Driven by a Few Customers

- Device Manufacturers
- Customers
- Equipment Suppliers
- Materials Suppliers
Requirements for the Semiconductor Industry

- Lower Cost
- Lower Power
- Higher Performance
- Form Factor
Themes: 2015 CMP Report Research

- Leading Edge Devices
  - New CMP processes
    - 3D transistor: Al and W for High k Gate Electrodes (new materials, removal rate, defectivity, selectivity)
    - 3D NAND: Defectivity for STI, PolySi, W
    - 3D Packaging: High RR Cu slurry for TSV
  - Tailored Consumables (HkMG polymer coated alumina particles; tunable pads for hardness & porosity)
  - Collaboration Across the Supply Chain will continue
  - Key Metrics: Defectivity, Planarization Efficiency, Polish selectivity, Cost

- Legacy Devices
  - CIP programs targeted to reduce cost & improve throughput

- Impact of the IoT?
CMP Materials & Processes
Growing Number of Process Steps

Source: IC Insights, KLA-Tencor
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Changes to Shrink Logic & RAM

65-45nm
- STI & CMP
- Strained Si Gate
- Co, Ni, W Gate Electrodes
- W Contact Cu wiring
- Low k dielectric (SiOF, SiOC)
- 193nm Litho

28/20nm Planar
- STI & CMP
- Strained Si Gate
- HkMG HfO$_2$ ALD
- TiN & Al Gate
- W Contact Cu wiring
- Low k & ULK dielectrics

22/20/16/14nm FinFET
- 2 STI for Fin Isolation
- HkMG HfO$_2$ ALD
- TiN TiAl W Gate
- 2 W Contact Cu wiring
- Co barrier, Ta @ larger Cu
- Low k & porous low k
- Multi Pattern Litho

↑ # metal levels
CMP Process Layers

- # CMP steps doubled from 28nm to 10nm
- # of FEOL/MOL CMP steps exceeded BEOL CMP steps starting at 14nm/FinFET
- 75% increase in MOL CMP steps from 14nm
Impact on Wafer Forecast
Wafer Starts per Year (200mm equivalent)
The Internet of Things
IoT Perception: Industry Executives

McKinsey GSA Alliance IoT Implications Survey

- 30 Sr executives across IoT ecosystem interviewed
- 229 semiconductor executives interviewed

Survey Results

- Some “ambiguity” if IoT will be a key growth driver
- 48% interviewed stated IoT would be a top 3 growth driver for the industry; with 17% ranking it as #1
- Cloud, software, security & systems integration viewed as best opportunities
IoT Process Node Breadth

IoT & Embedded SOC Implementation x Process Node

- BCD/HV
- Analog M/S
- uLL TGO Logic
- Ultra-low Power Memory
- Embedded MCU/Flash
- Base CMOS Logic
- Motor Control
- Battery Monitoring
- Sensor Networks
- PMIC
- LED Lighting
- Touch-screen Controllers
- Stability Control
- Body control Sensors
- Tire pressure Sensors
- Body Control Pressure Intruder Sensors
- Smart Meter
- Medical Electronics
- eDashboard
- IoT Connected Devices
- Wearable Devices
- Infotainment
- ABS/Airbags
- Electronics Stability Control

“More than Moore”

- Embedded MCU
- Embedded Flash
- Real-time MCU
- Apps Processor Core

90-180nm → 55/65nm → 40-28nm
Semiconductor Opportunity – IoT

Semiconductor Revenue (Millions of Dollars)

- IoT revenue $24 billion
- Semiconductor revenue $384 billion

*Only IoT capability is captured under revenue for Things

Permission granted by Gartner
MEMs Total Units Forecast

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CAGR: 24.8%

Source: Semico Research Corp
Changes to Shrink Logic & RAM

> 180nm
- STI & CMP
- PolySi & silicides Gate Electrodes
- W Plugs/Al wiring (4-6 layers)
- TEOS
- 248nm litho

180nm
- STI & CMP
- Co, Ni, W Gate Electrodes
- W Plugs/Al Wiring (4-6 layers)
- TEOS
- 248nm litho

130nm
- STI & CMP
- Co, Ni, W Gate Electrodes
- W Contact Cu wiring (6-8 layers)
- Low k dielectric
- Phase Shift Litho

90nm
- STI & CMP
- Co, Ni, W Gate Electrodes
- W Contact Cu wiring (6-8 layers)
- Low k dielectric (SiOF)
- Phase Shift Litho
- 300 mm wafers

↑ # metal levels
CMP Market Update
Normalized Pad & Slurry Revenue

Pad 5 year CAGR 5.3%
Slurry 5 year CAGR 5.6%
CMP Slurry Revenue 200mm & 300mm

% Slurry Revenue


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Pad and Slurry Revenue by Application

Combined Pad & Slurry Revenue (US4M)

- Cu Barrier
- Cu Step 1
- Tungsten
- Oxide
- HkMG Oxide
- HkMG
- Electrode
- S-STI

See 2015 CMP Report
2015 CMP Consumables Market Shares
Total TAM $2.24B

- Slurry, $1,260M
- Pads, $685M
- Conditioners, $205M
- PVA Brushes, $48M
- Slurry Filters, $43M
CMP Supply Chain Impacted by IoT

- “Significant – extreme” pricing pressure
- Legacy slurries are being used and will grow very slightly (STI/oxide/W/Cu)
- Competition in both pad and slurry market
- Crowded ceria slurry market
- CIP programs continue; changes to POR when CoO/tpt gain > cost of requalification
- Supply chain capacity well positioned
Techcet Materials Coverage includes:

- ALD Hi K Precursors
- CMP Consumables
- Dielectric Precursors
- 3D/TSV Packaging
- Gases
- Graphites
- Photoresist & Ancillaries
- Quartz
- Silicon Carbide
- Silicon Wafers
- Sputtering Targets
- Si Equipment Components
- Wafer Level Packaging (WLP) Polymers
- Wet Chemicals
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Techcet’s 2015 CMP Critical Materials Report

- Available as Full Report or by Individual Consumable
  - 11 Sections
  - 7 Markets Segments
  - >170 Supplier Profiles
  - Process Flows

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