2009 Market Slurries and Particles in CMP & a Bit Beyond

NCCAVS CMPUG Semicon W Meeting

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July 14, 2009

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Slurries & Particles in High Tech

- IC CMP is by far the largest in Revenues
- Si Wafer production
  - Cutting the Si Ingot into wafers uses SiC cutting fluids
  - Si Wafer polishing and final polish use high purity & excellent surface quality CMP with silicas
- Lower tech applications abound … re-use of spent CMP slurries?

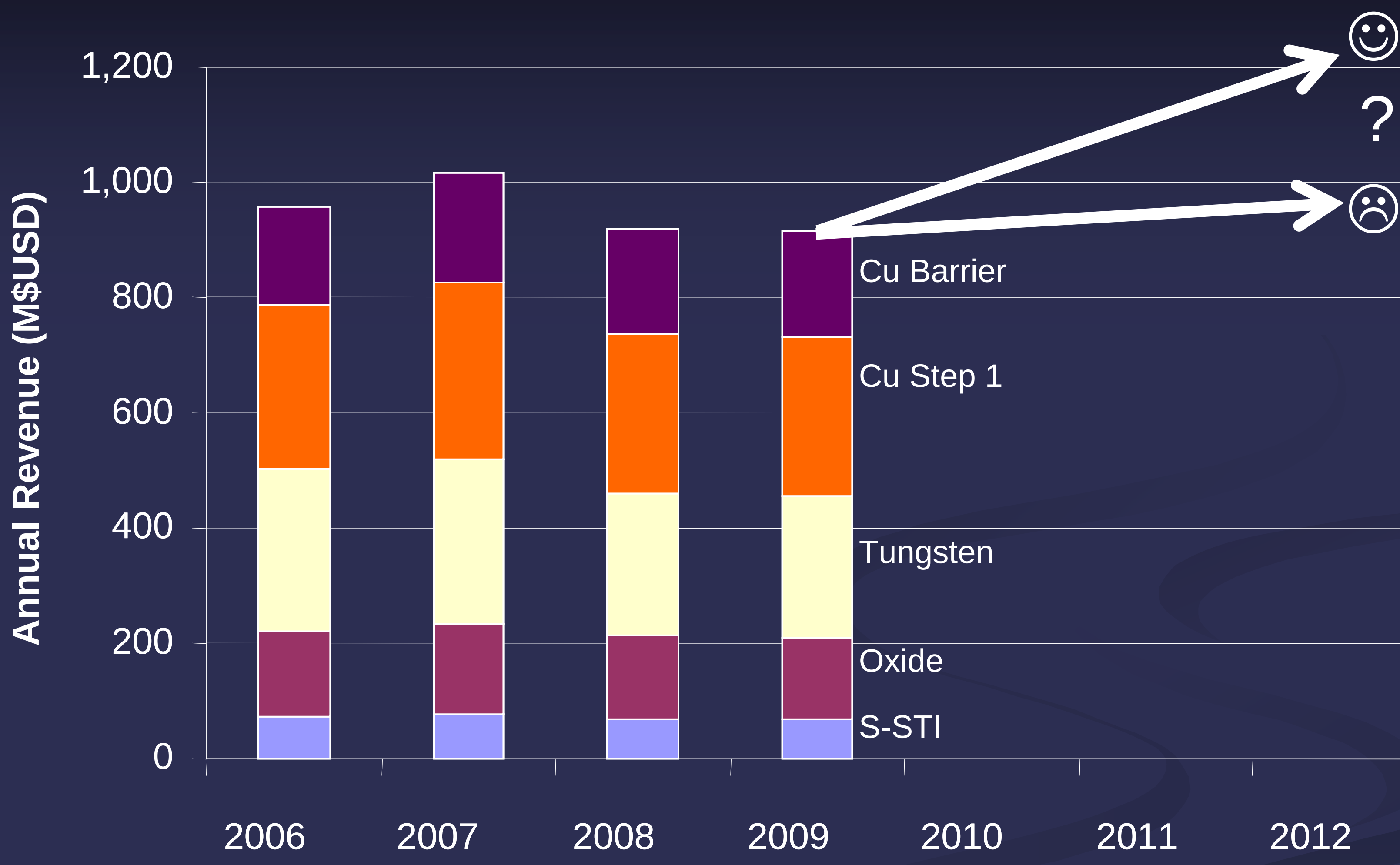
Major Slurry Trends

- For IC manufacturing, silica dominates the slurry market in amount used
- For STI, ceria is preferred for more advanced technologies, but is much more expensive per gram.
- For Wire Cutting of the Si Ingot (IC and Solar) SiC particles are used as cutting fluid
- For Si wafer manufacturing polish it’s silica

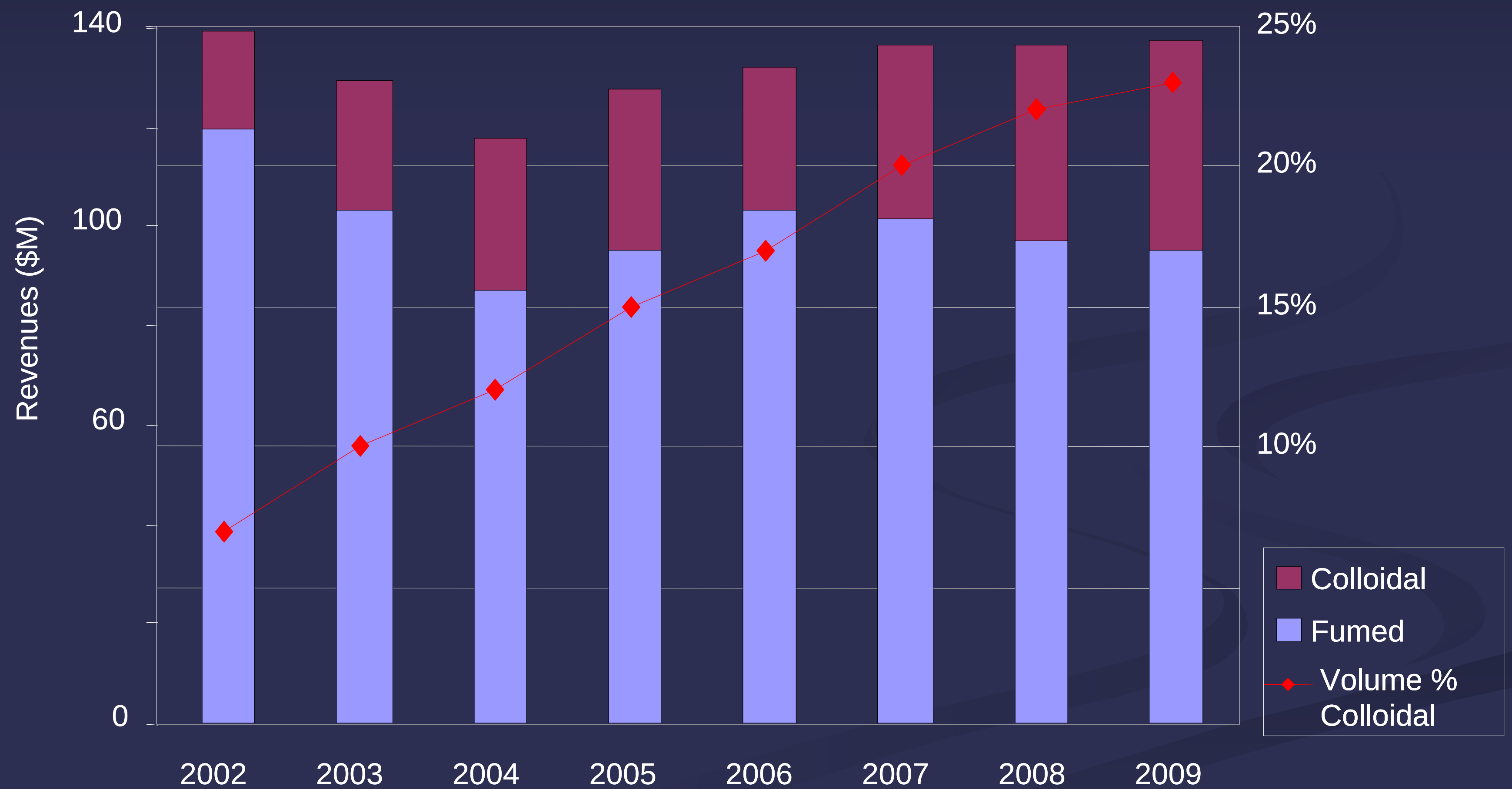
Silica for CMP

- Silica Comes in 3 Types
  - "Fumed": flame vapor-phase hydrolysis of $SiCl_4$ or the like … 3 major suppliers
  - "Colloidal": precipitated from sodium silicate & H_2SO_4 … >8 suppliers
  - "Sol": Stöber process condensation of silicon alkoxide (TEOS, TMOS) w/ ammonia & water, at least 2 major suppliers
- Abrasives and Applications
  - Oxide/ILD ≤65nm use less aggressive particles: fumed to colloidal or milled fumed
  - Copper "Step 1" predominately uses Colloidal
  - Copper Barrier (and Dielectric Cap) uses Colloidal or Sol
  - Tungsten fumed and colloidal

IC CMP Slurry Growth ?



ILD Abrasive Migration



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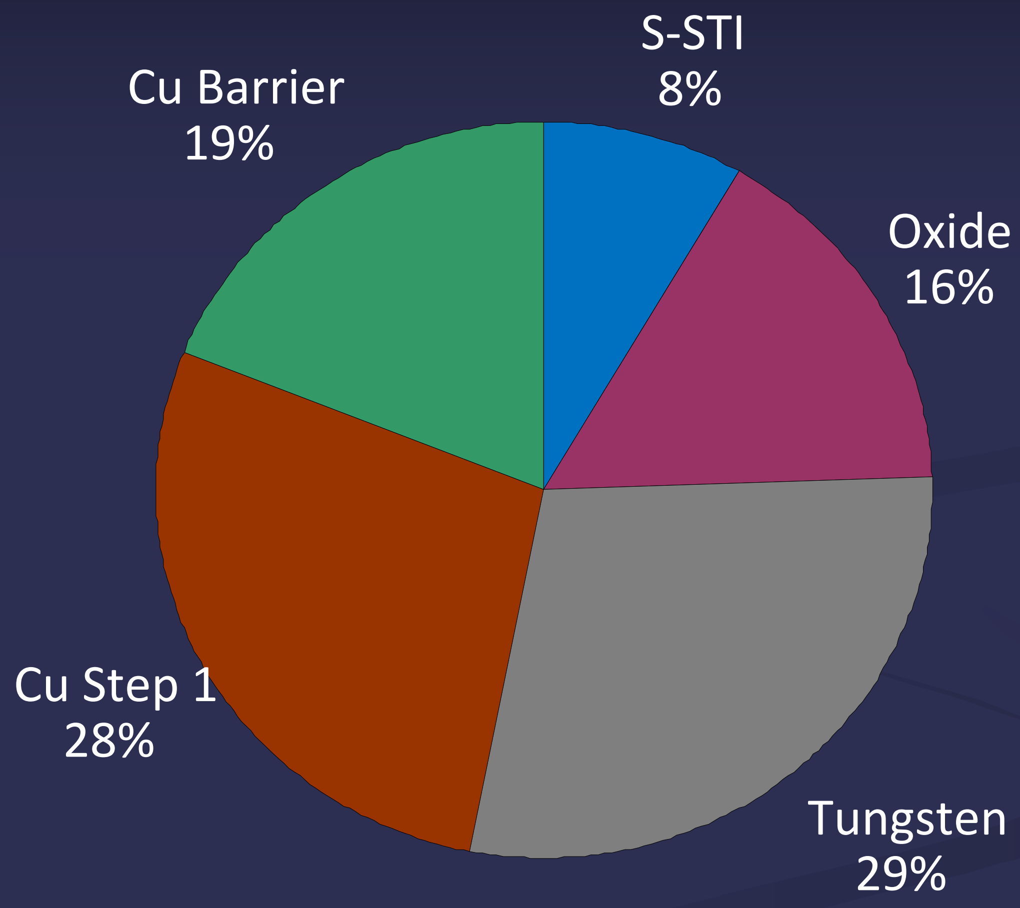
Abrasive and Slurry Suppliers

- Numerous Suppliers of Slurry (>21)
  - Abrasives only (>15)
  - Slurries only (>15)
  - Both Slurry and Abrasives (>6)
- Unlike CMP Pads, the Slurry and Abrasive Supplier List is Stable

IC CMP Slurry Market Size by Application Revenue



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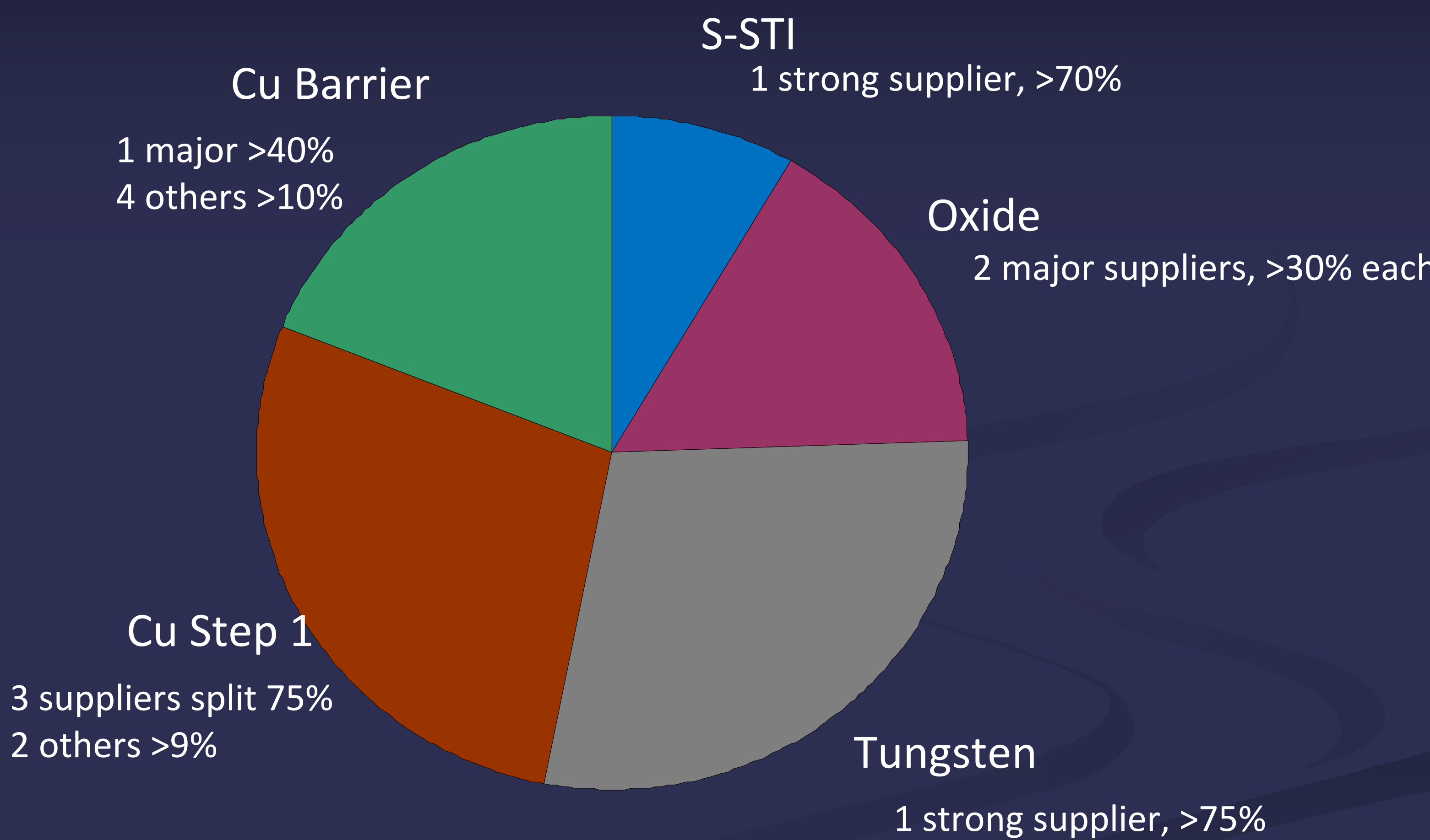
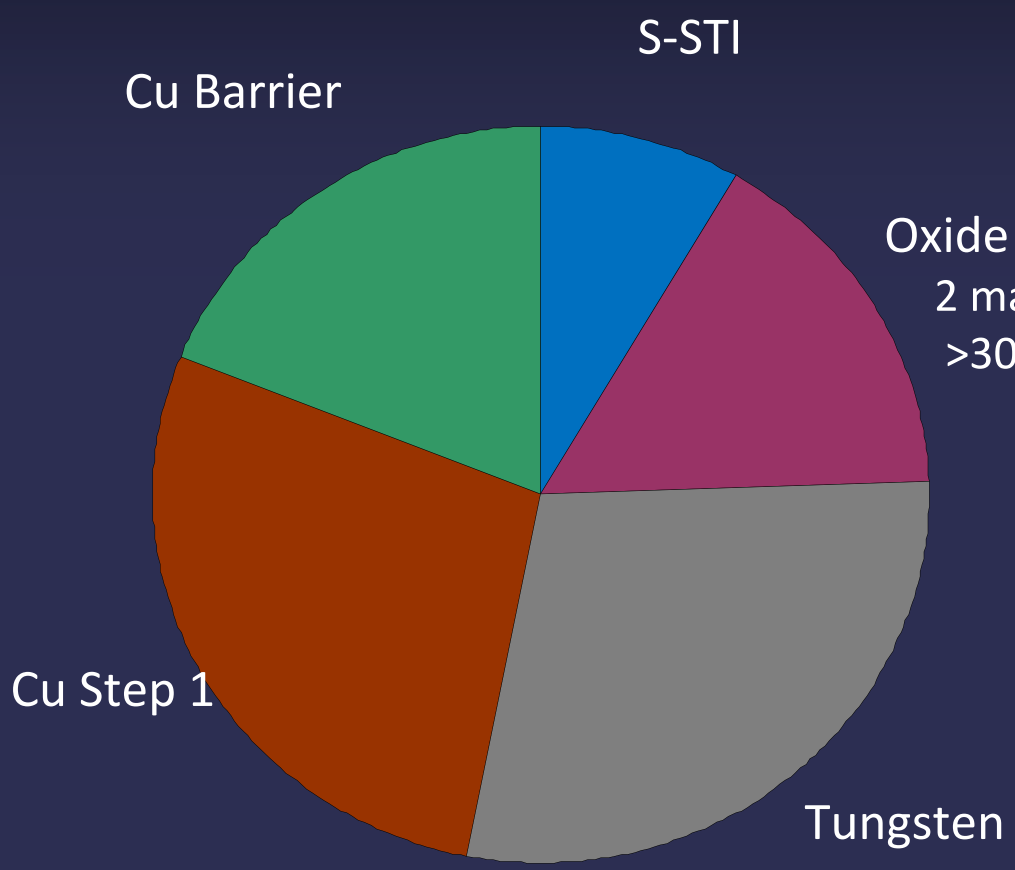
IC CMP Slurry Suppliers



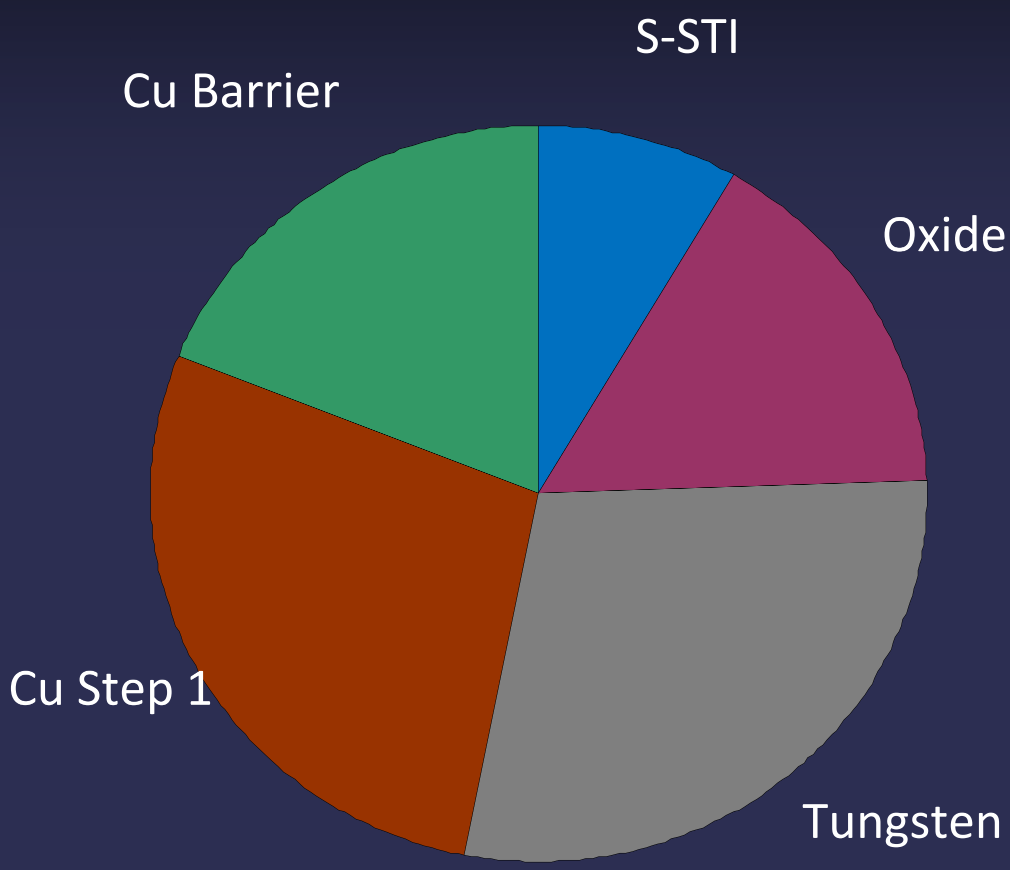
IC CMP Slurry Suppliers



2 major suppliers
>30% each

- Commodity business
- Customer pricing pressure
- Low passes per wafer start in newer nodes
- Opportunities in ≤ 45 nm

IC CMP Slurry Suppliers



1 strong supplier, >75%

- Aggressive patent defense
- W not large growth market
- Slurry dilution & competition would erode margins

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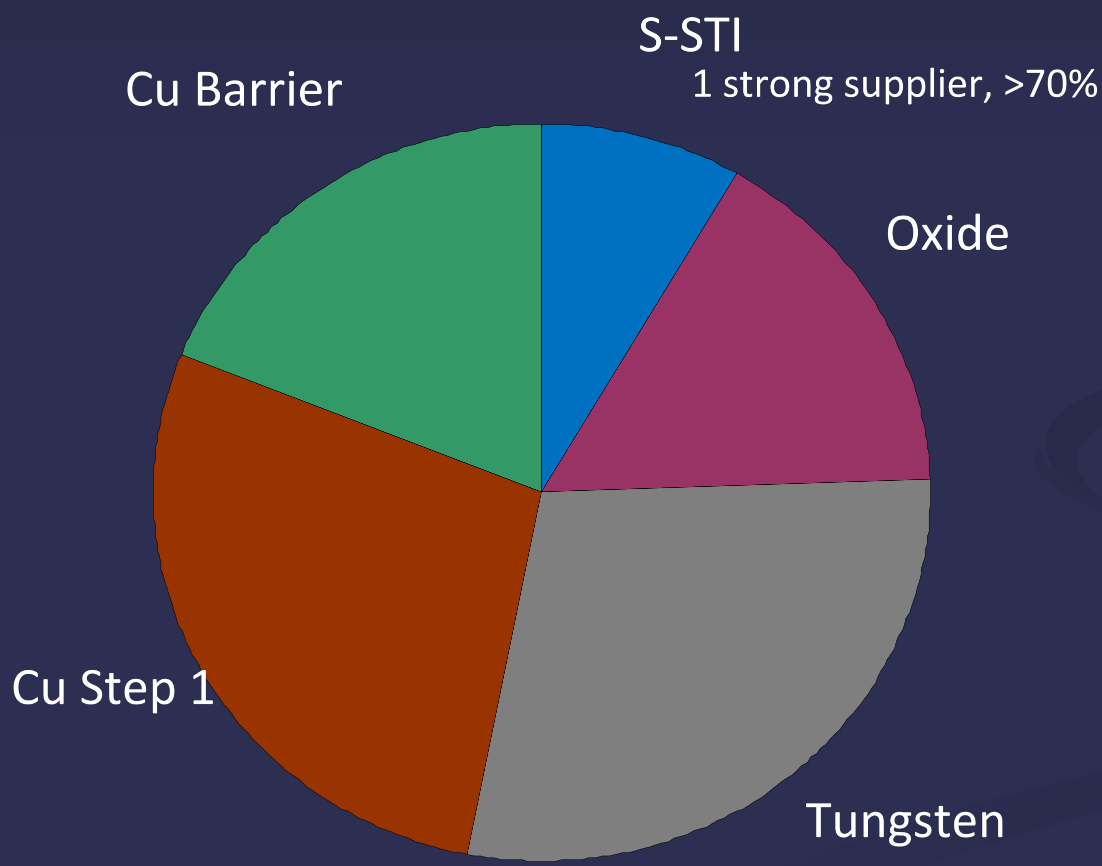
IC CMP Slurry Suppliers



- Mostly ≤ 65 nm
- Single process per wafer start
- Cerium is costly

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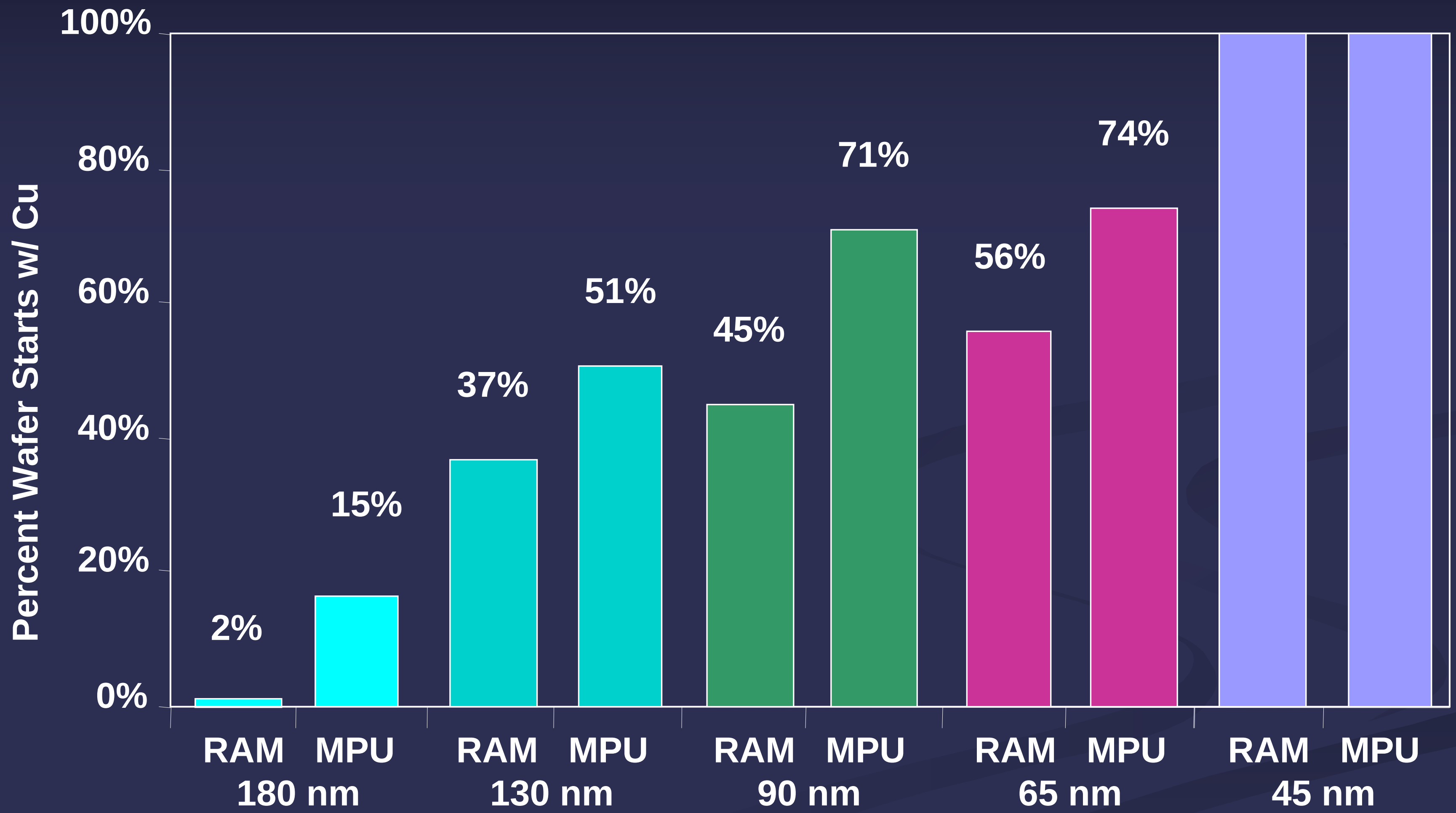
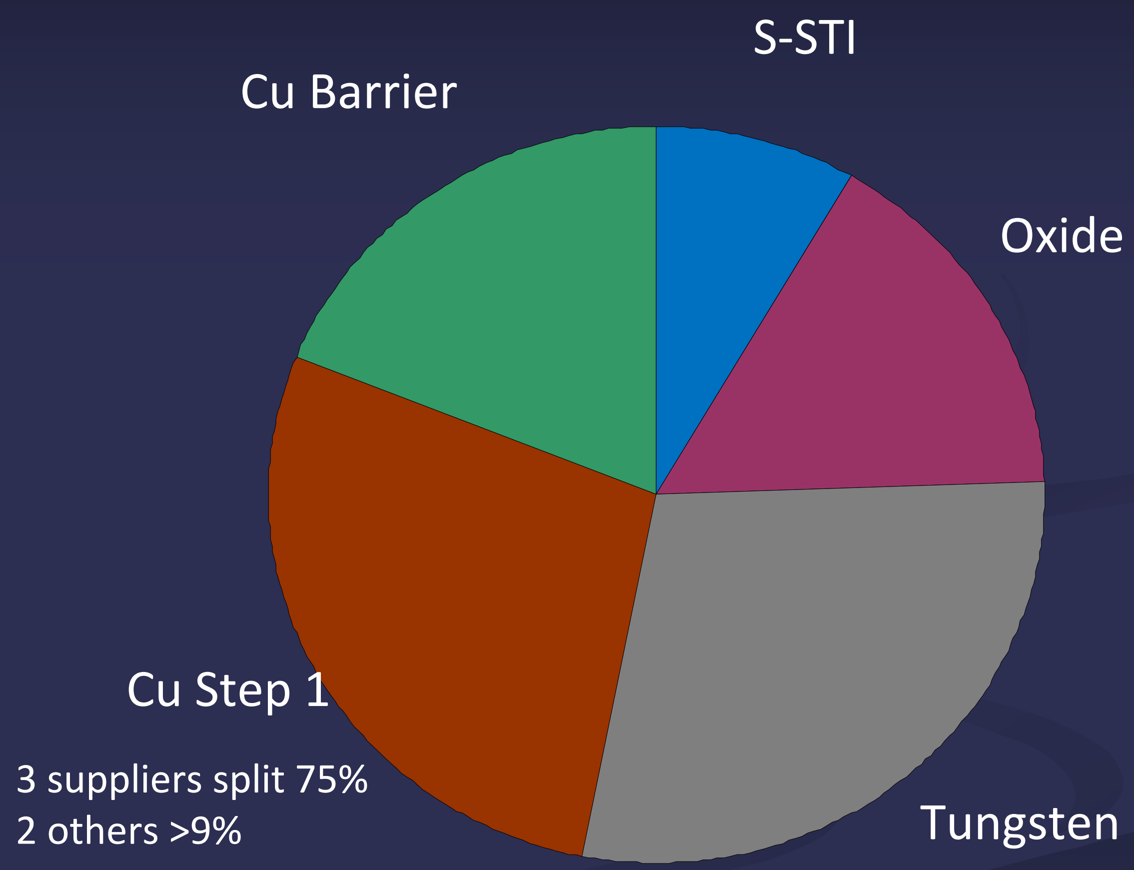
Transition to Copper Interconnects



IC CMP Slurry Suppliers



- High growth
  - Transition to Cu from Al
  - Growing passes per wafer start
- Customers' priorities differ
- New slurries for each new generation?

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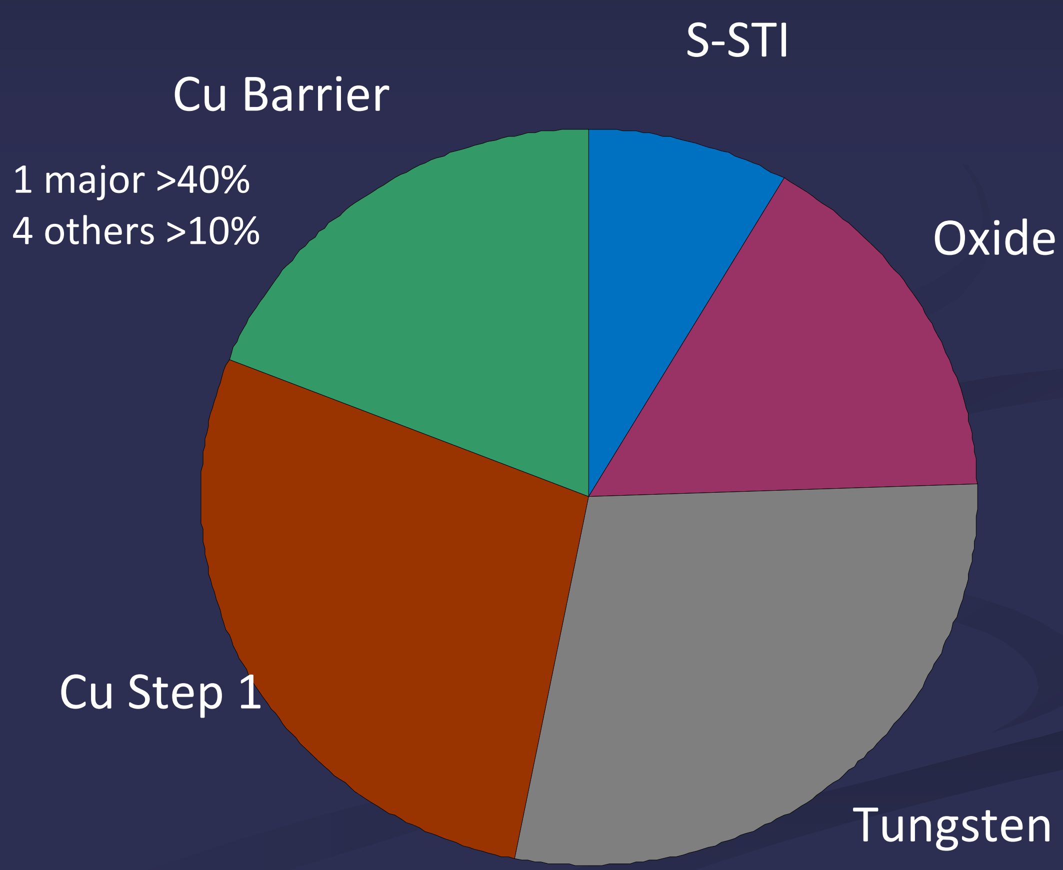
IC CMP Slurry Suppliers

- High growth, but less volume than Cu polish
- Customers' priorities similar
- New slurries for each new generation due to low k dielectrics?



IC CMP Slurry Challenges

- ILD/PMD/Oxide
  - Commoditization and Affect on Suppliers
  - Improved surface finish post CMP
- Selective STI
  - Lower Defects and Lower Cost (Ceria Expense)
- Tungsten
  - Lower Defects and Lower Cost (Competition)
- Copper and Barrier
  - Each Cu Node Expects a New Formulation
  - Costly for Supplier, Pricy for End User
- FEOL Polish
  - Polish of ILD thru poly gate prior to poly etchback and metal gates

Si Wafer and Slurry

- SiC for Si ingot slicing not a large market
- Solar use is >5x the volume of IC wafers
- SiC revenues will approach $40M in 2009

Slurry Disposal

- Lower tech applications abound
- Reclaim and re-use of spent CMP slurries
  - Concentrate used slurry
  - Reduce heavy metal contamination
- Road filler or ??
- Does it pay to be green?

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