Rebounds & Magic Triangles

Techcet CMP Consumables 2011 Market Update

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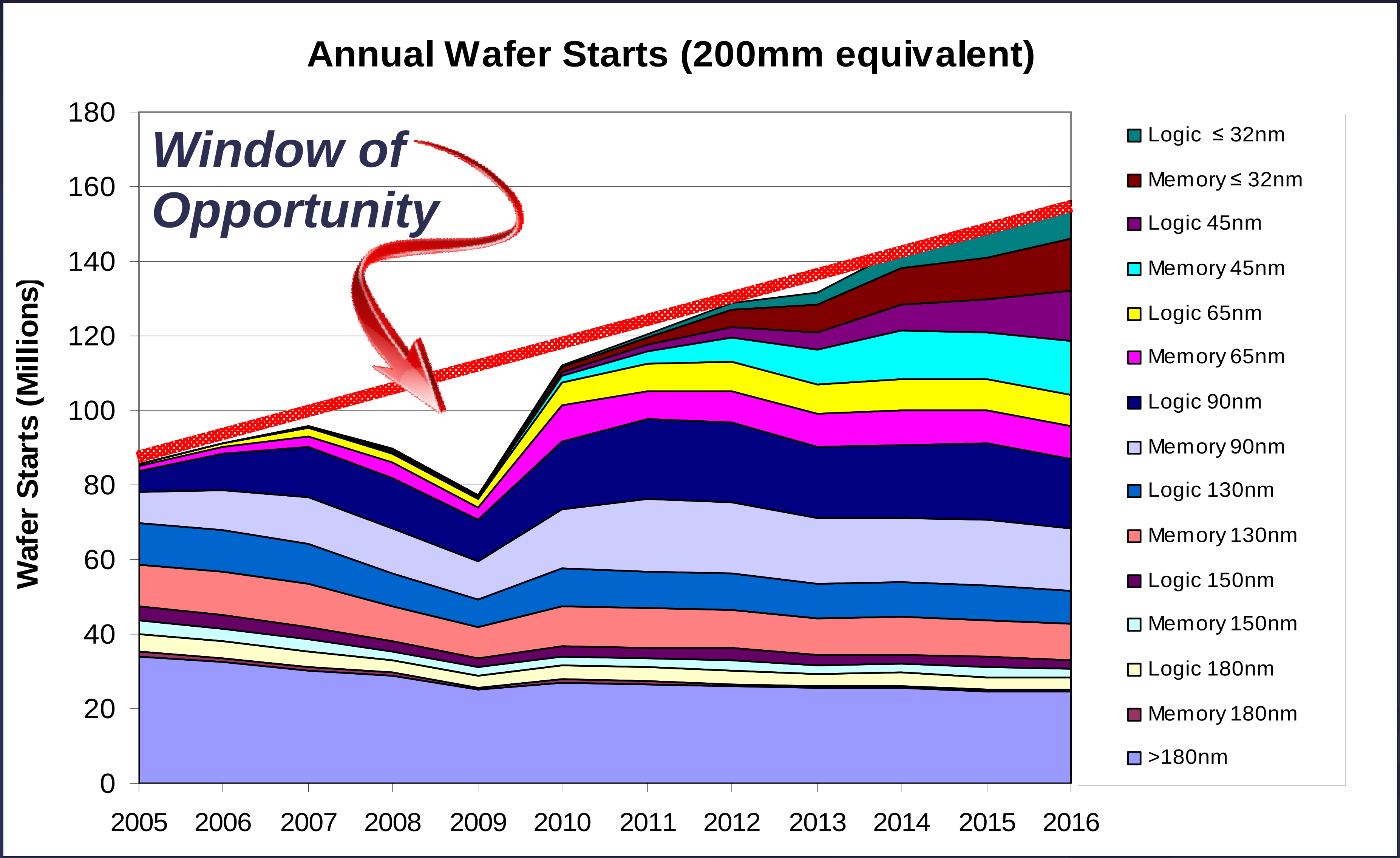
Outline

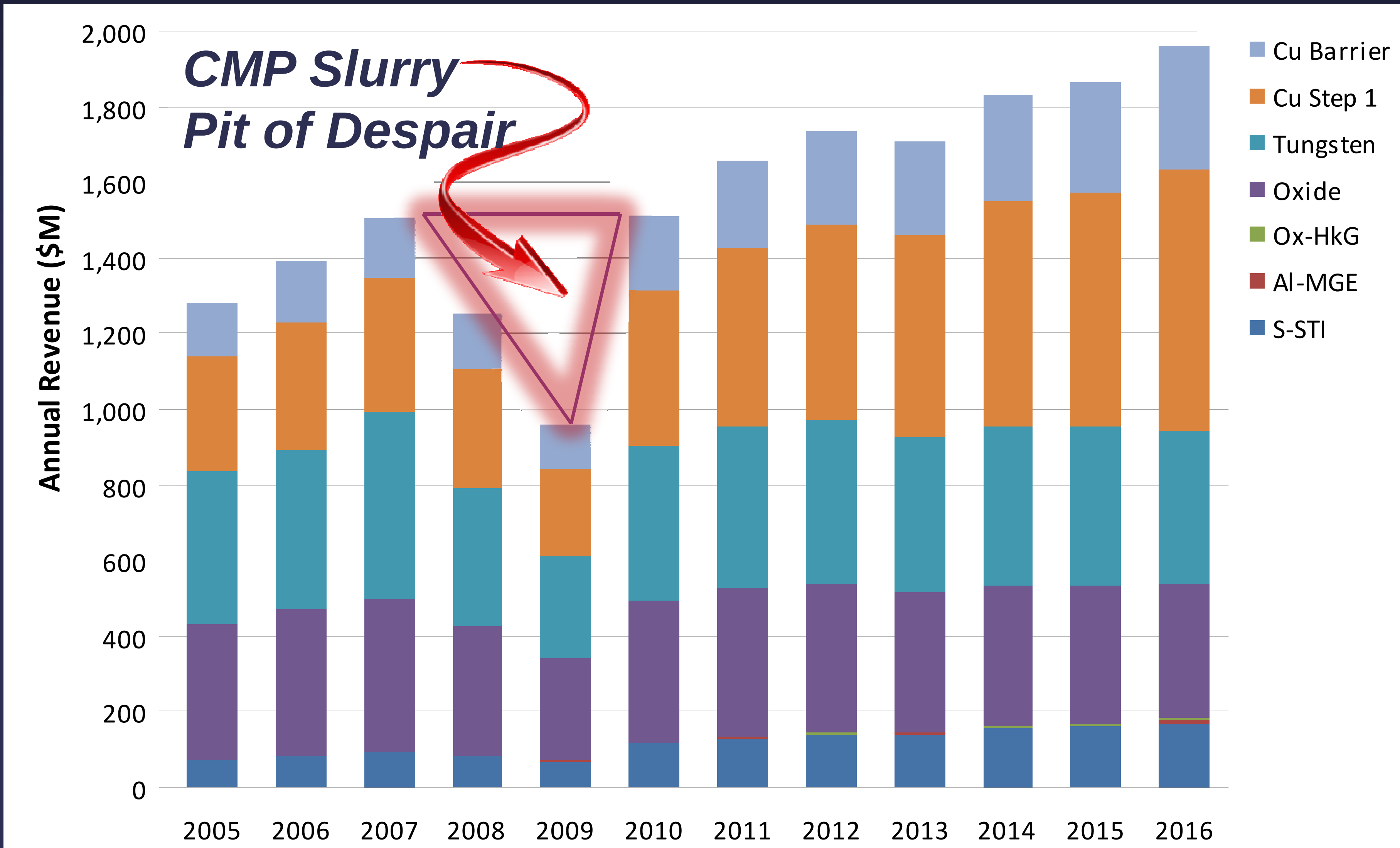
- The Business
- The Players
- The Buzz
- The End

The Business of Semiconductors



Source: Techcet Group, April 2011

The Business of CMP



Source: Techcet Group, April 2011

The Business of CMP

- 2010 revenues match 2007 peak
  - Up 37% over 2009 low
  - 2011 forecast +9% to $1.65B
- Revenue shift
  - More copper & STI
  - Less tungsten & ILD
- CMP recession impacts
  - Leading edge – what recession?
  - One supplier drop out (SemiQuest)

The Players - Slurry

- FujiFilm absorbs 100% of Planar Solutions
- BASF enters the CMP slurry business

- >15 suppliers share $1.03B market
  - Tier 1 – Cabot Microelectronics ~40% share
  - Tier 2 – DANM, Dow, FujiFilm, Fujimi, Hitachi
    - Shares 5% to 11%
  - Tier 3 – Anji, AGC, ATMI, BASF, Bayer, Cheil, Ferro, JSR, Wacker
    - Shares <5%

The Players - Pads

- Investor confidence: new funding rounds
  - innoPad $6M, April, December 2010
  - NexPlanar $10M Series D, March 2011
- >16 suppliers share $626M market
  - Tier 1 – Dow ~80% share
  - Tier 2 – Cabot ~5–7% share
  - Tier 3 – innoPad, JSR, Praxair, Thomas West
    - Shares 3–5%
  - Others – 3M, Fujibo, IVT, KPX, NexPlanar, Rogers, SKC, Toray, Toyo, Toyobo

The Players – Other CMP

- Pad conditioners
  - Market size estimates range $200M – $400M
  - 3M & Kinik control over half the market
- PVA brushes
  - Market size estimated $30M – $50M
  - ITW & Aion control 80% of the market
  - ~$10M market for HDD
- Slurry filters
  - Pall, Entegris & 3M dominate

The Buzz – Magic!

Slurry

Unexpected
Exceptional
Performance

Pad

Conditioner

Magic Triangles

- Why now?
  - Years of talk about synergy between pad and slurry development produced *nothing*
  - <45nm specs made us look more closely
- Systematic engineering work
  - Designed experiments
  - New products available for evaluation
  - Fab tool time available
  - Fab engineer work product, no R&D transfer

Magic Triangles

- Process characteristics
  - Less aggressive pad conditioning
  - Highly reproducible pad roughness
  - Tight slurry PSD
- Resulting observations
  - Sharp reduction in surface scratches
  - Dishing meets aggressive specs
  - Exceptional removal rate stability
  - Lower CoO (pad life, conditioner life)

Magic Triangles

- Specific examples: CONFIDENTIAL
  - Patriot Act does not apply
  - Enhanced interrogation techniques off limits
    - *Slurry-boarding on hold*

- Magic triangle citations
  - Cabot (pads)
  - Fujimi
  - Hitachi
  - innoPad
  - Intel
  - Morgan

Magic Triangles vs. ITRS

Table FEP14 Shallow Trench Isolation CMP Process Technology Requirements						
Year of Production	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
DRAM ½ Pitch (nm) (contacted)	52	45	40	36	32	28
MPU/ASIC Metal 1 (M1) ½ Pitch (nm)(contacted)	54	45	38	32	27	24
MPU Physical Gate Length (nm)	29	27	24	22	20	18
Wafer diameter (mm)	**300**	**300**	**300**	**300**	**300**	**450**
Wafer edge exclusion (mm)	**2**	**2**	**2**	**2**	**2**	**2**
Scratches						
Critical scratch length, s_c (nm) [A]	**25.8**	**22.5**	**20.0**	**17.9**	**15.9**	**14.2**
Critical scratch count, S_{pw} (#/wafer) [A]	**40.1**	**40.1**	**40.1**	**40.1**	**40.1**	**166.3**
Uniformity						
CMP total uniformity (3σ) for removal (%) [A]	**8**	**8**	**8**	**8**	**8**	**8**
CMP uniformity (3σ) within wafer (%) [A]	**6**	**6**	**6**	**6**	**6**	**6**

Manufacturable solutions exist, and are being optimized (white)
Manufacturable solutions are known (yellow)
Interim solutions are known (yellow/red striped)
Manufacturable solutions are NOT known (red)

- Magic triangles will contribute to success
  - Critical scratch length <20nm, <40/wafer

Source: 2010 Interconnect ITRS

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The End

- CMP market has recovered to its pre-recession trajectory
- CMP users and suppliers will both benefit from magic triangle work completed during the recession
- It is time for a CMP Slurry Market Statistics Program

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