CMP Market And Technology Status - 2002

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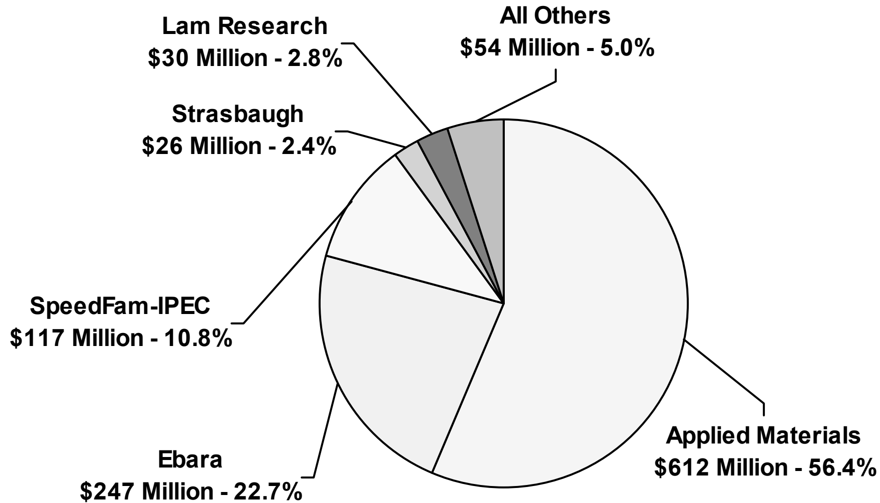
October 10, 2002

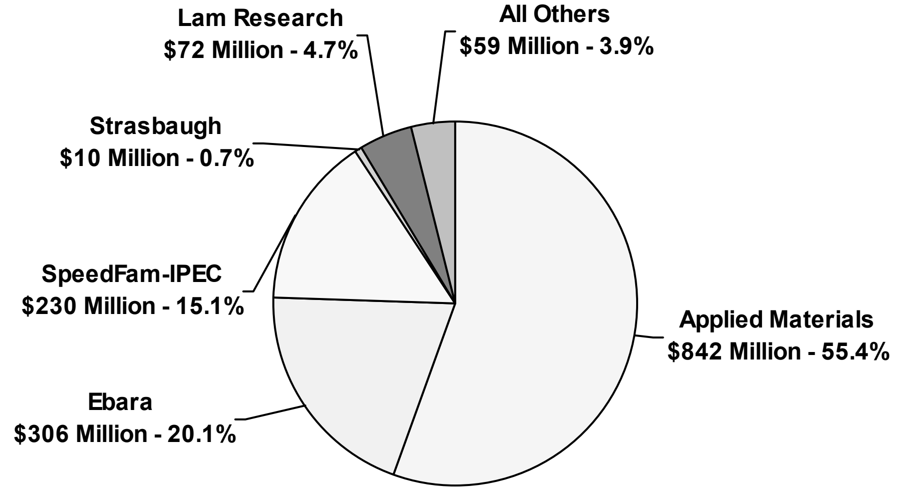
Agenda

- Review of 2001 CMP Markets
- Forecast For CMP Market Segments For 2002-2008
- Potential Technology Shifts That Can Impact CMP Markets (And This Forecast)
  - Review of 2001 US CMP Related Patent Activity
  - Possible Technologies For Planarizing Mechanically Weak Interconnect Structures
- Conclusions

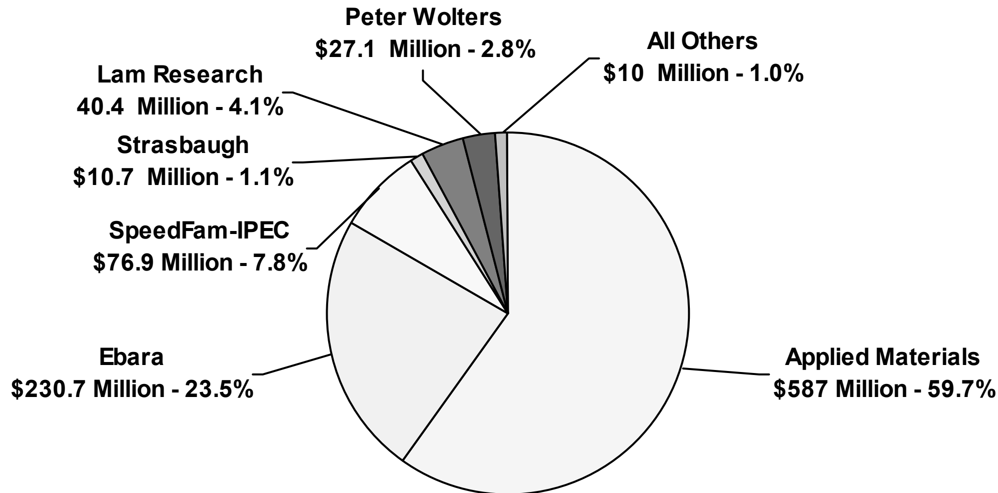
CMP Revenue Market Shares: 1999 - 2001



1999 Revenues - $1.086 Billion



2000 Revenues - $1.519 Billion



2001 Revenues - $982.8 Million

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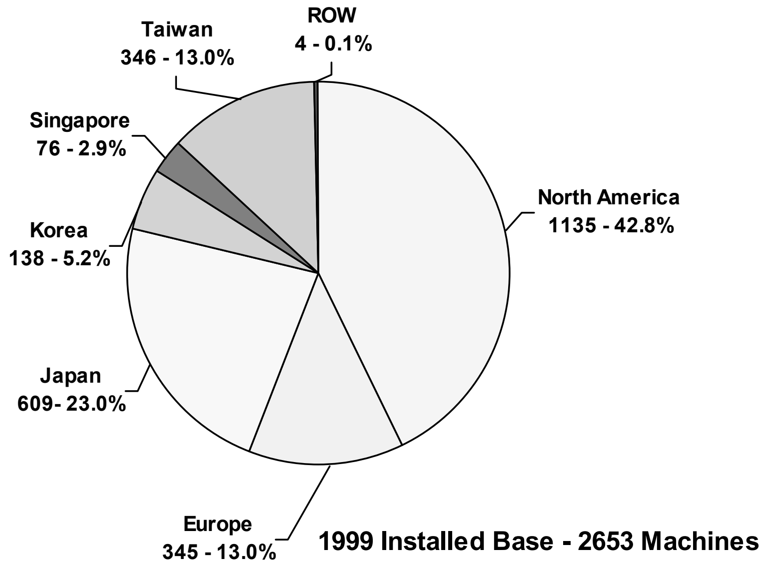
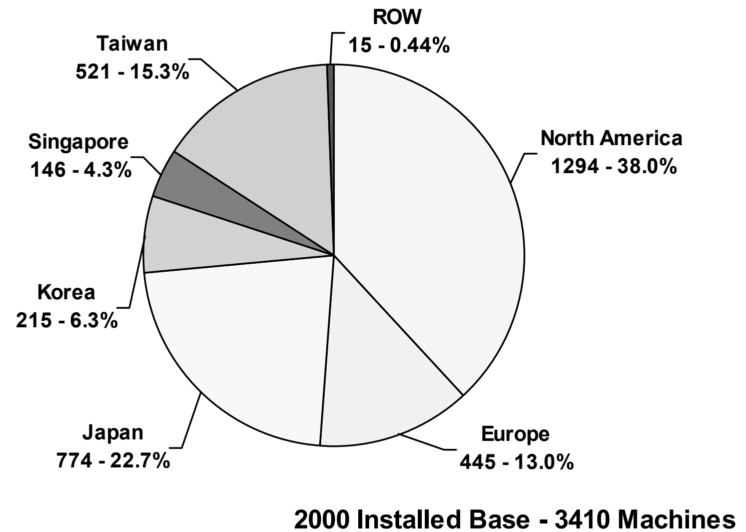
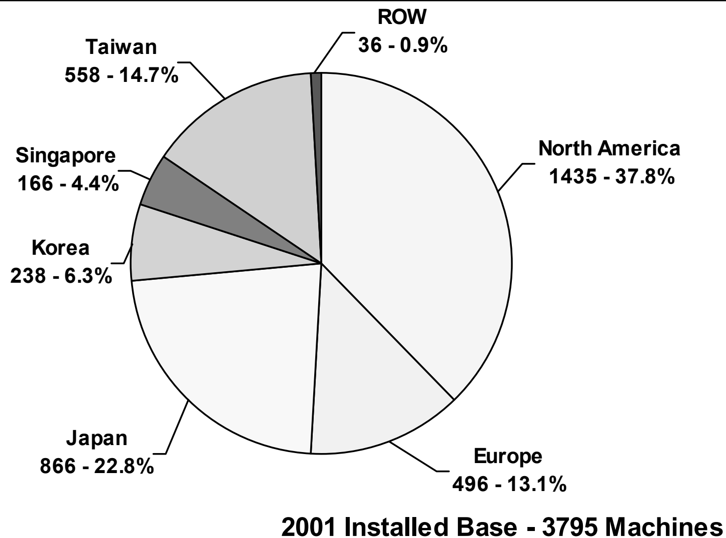
Geographic Distribution Of CMP Tool Shipments For Calendar Year 2001



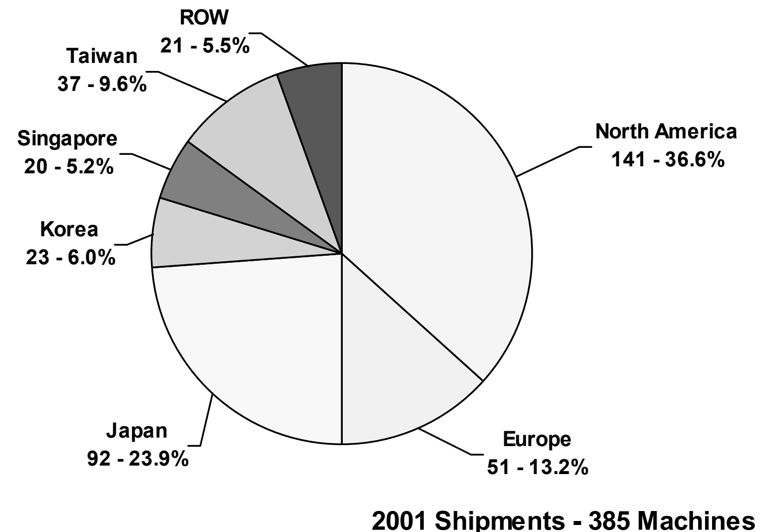
1999 Installed Base - 2653 Machines



2000 Installed Base - 3410 Machines



2001 Installed Base - 3795 Machines



2001 Shipments - 385 Machines

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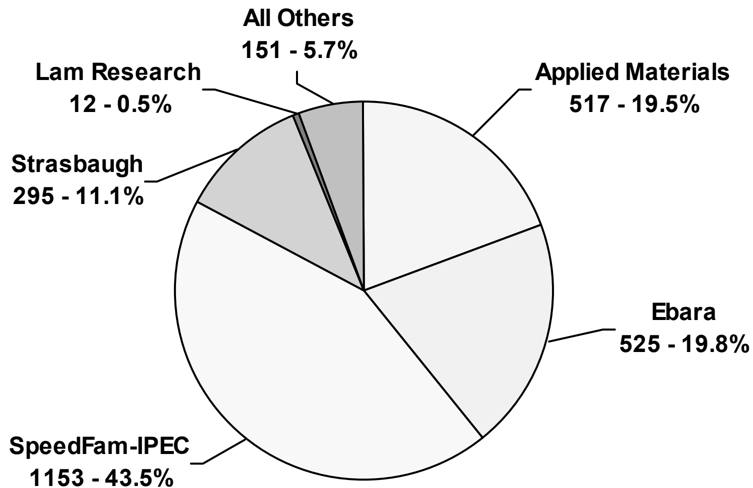
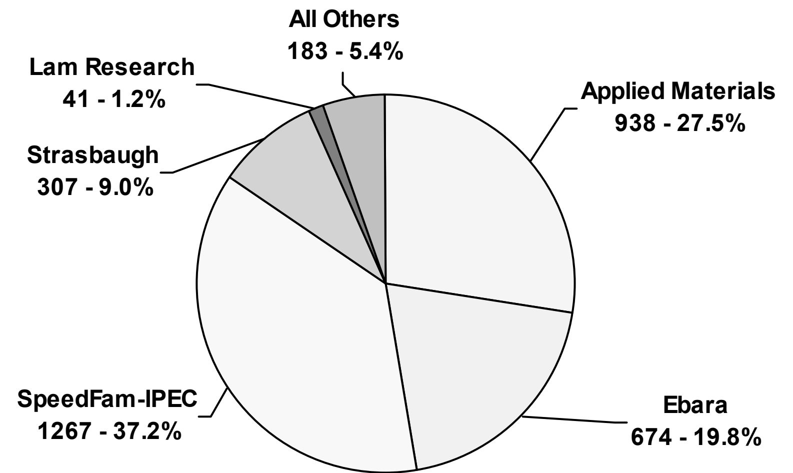
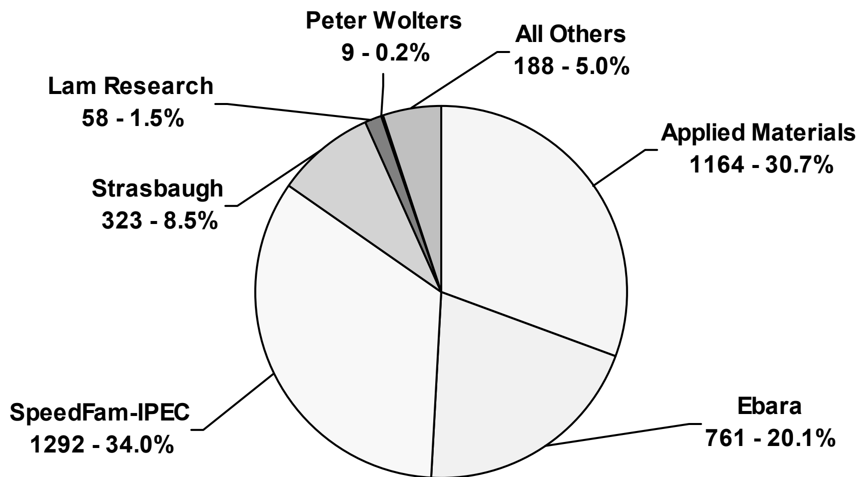
CMP Tool Shipments For Calendar Year 2001 By Supplier



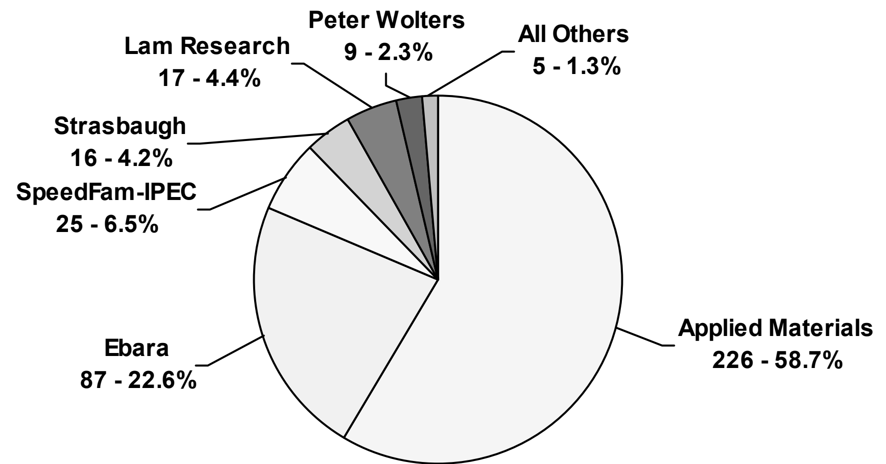
1999 Installed Base - 2653 Machines



2000 Installed Base - 3410 Machines



2001 Installed Base - 3795 Machines



2001 Shipments - 385 Machines

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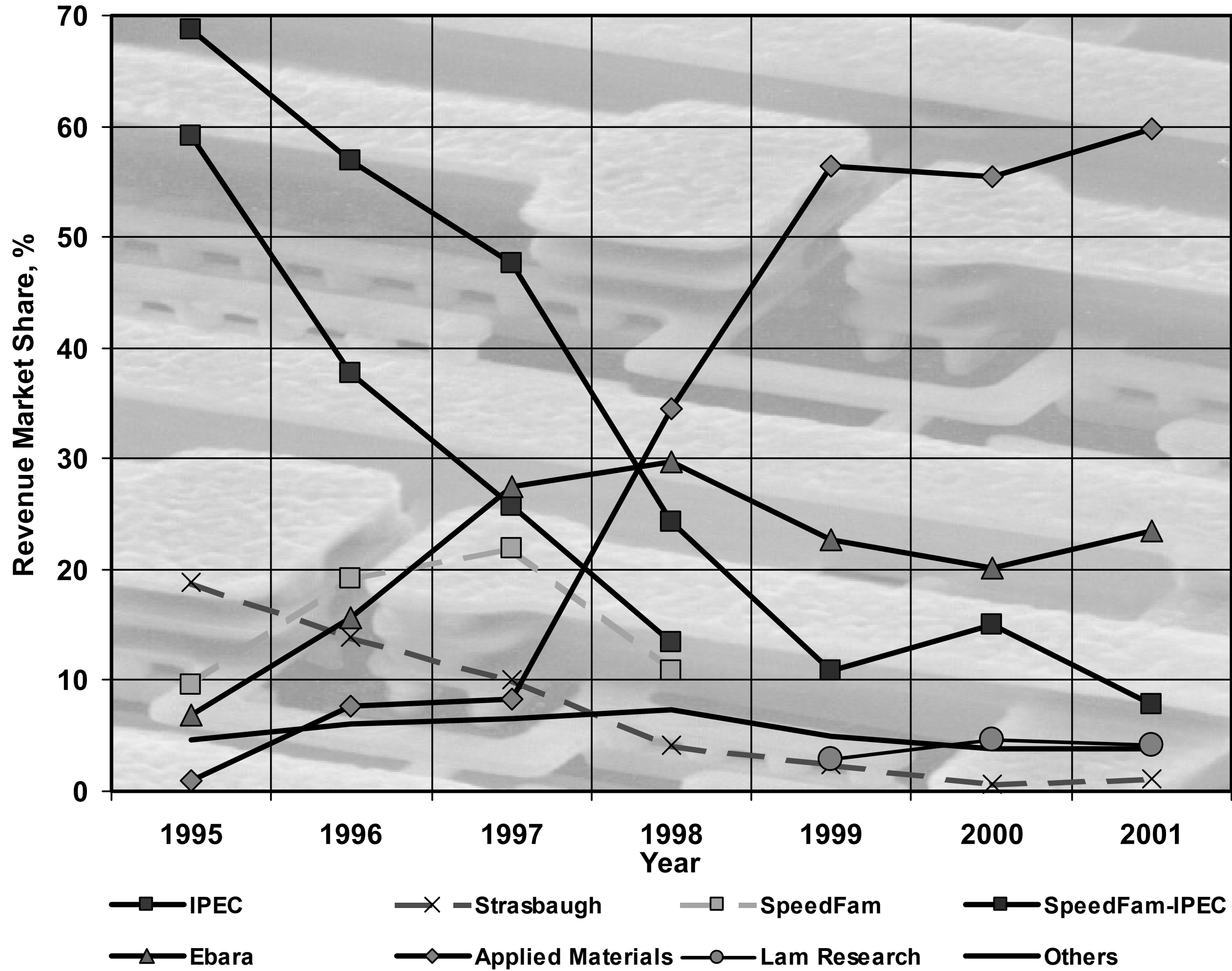
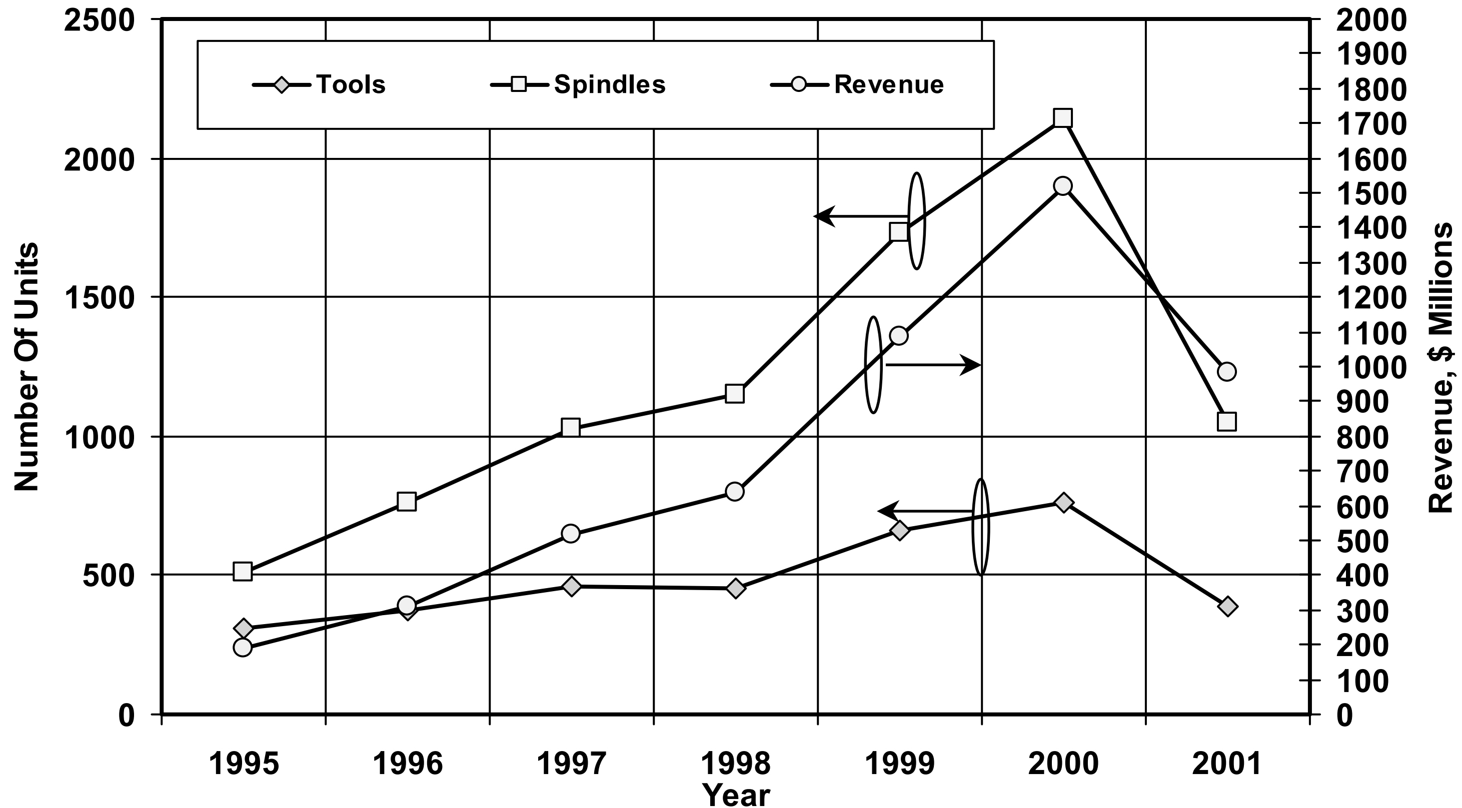
CMP Market Share Trends 1995 - 2001

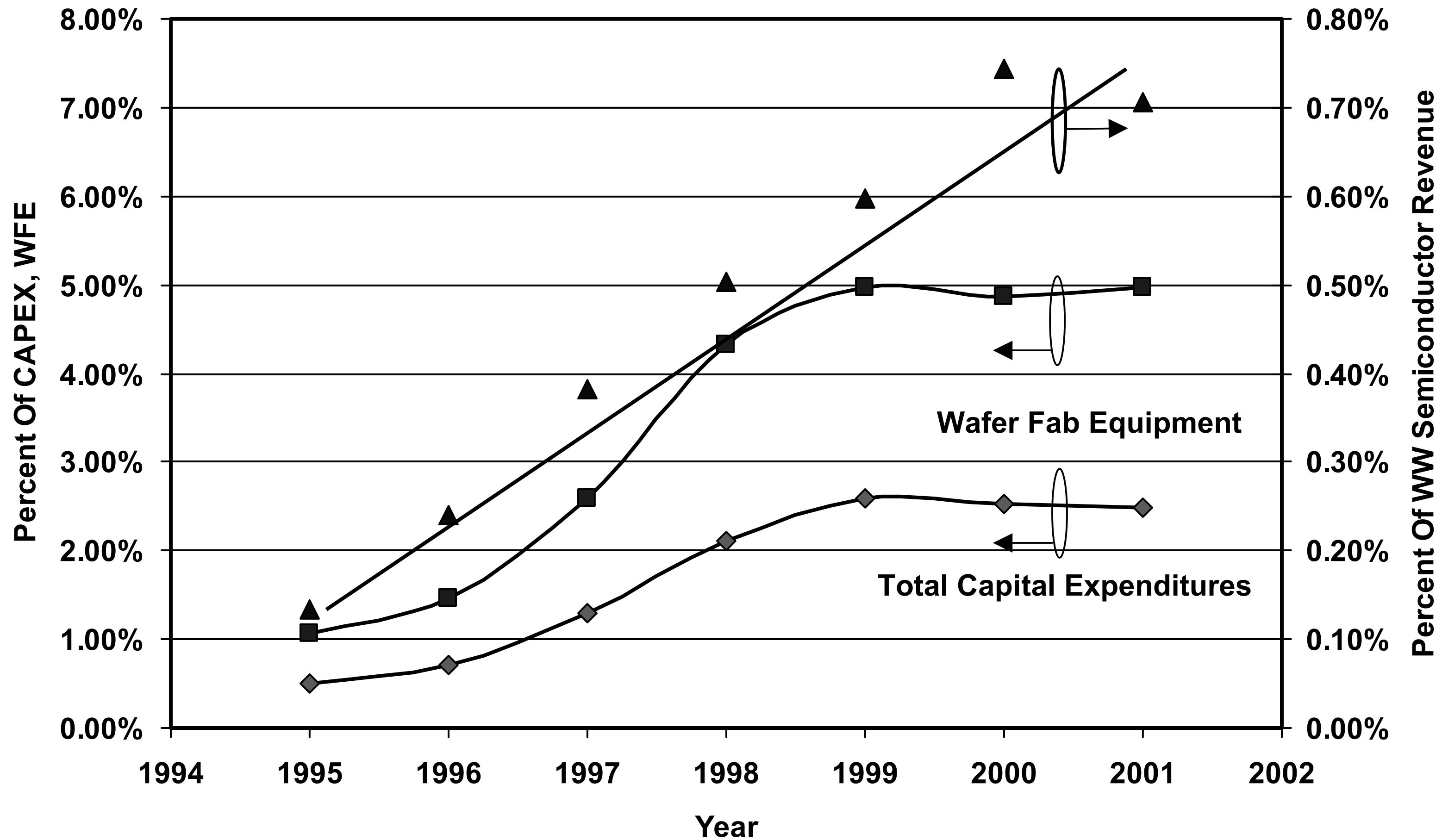


CMP Market Changes: 1995 - 2001

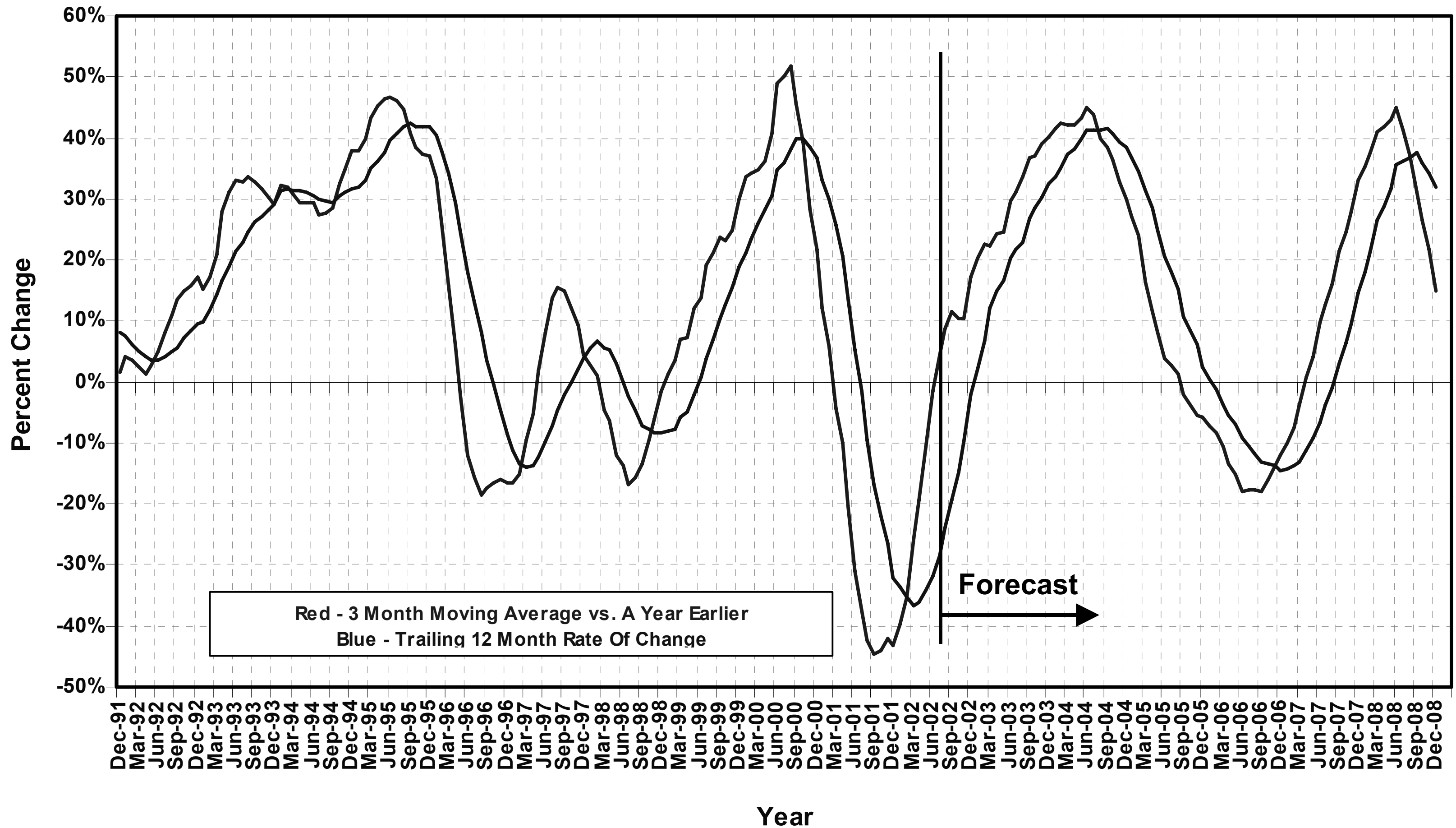


- ❖ Transition From Single Spindle To Multiple Spindle Units
- ❖ Transition From Standalone Units To Dry-In Dry-Out Systems
- ❖ Incorporation Of Onboard Or Inline Metrology On CMP Systems
- ❖ Advanced Carrier Designs
- ❖ More Sophisticated Control Systems
- ❖ Overbuying in 1998 – 2000

CMP Revenue As A Percent Of CAPEX, WFE And Global Semiconductor Revenues (Adjusted)



Global Semiconductor Revenue Trailing Twelve Month Growth Rate And Percent Change In Three Month Revenue Moving Average Vs. The Year Earlier Comparable Period (Forecast)



Source: WSTS Data

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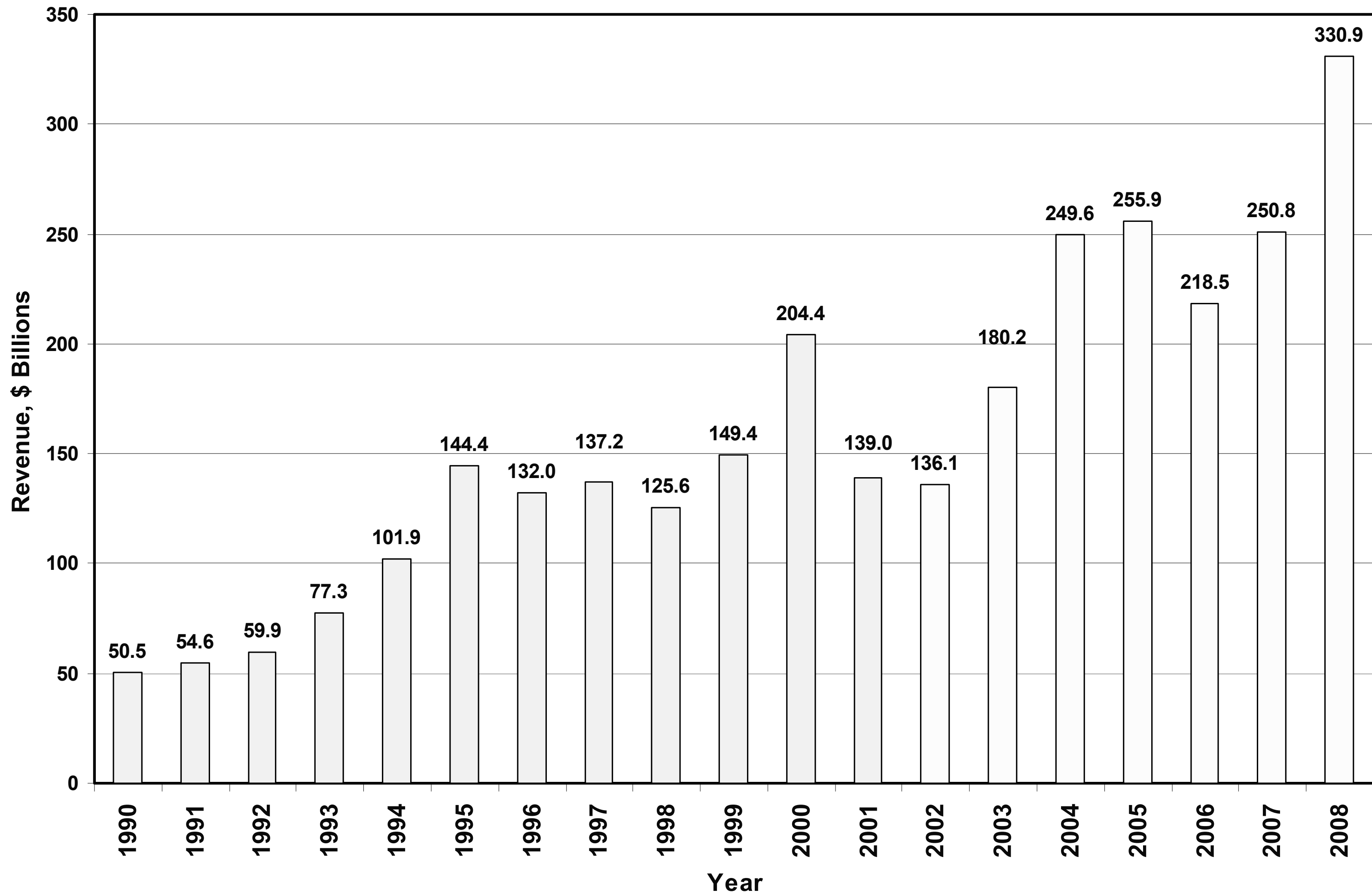
Semiconductor Industry Revenues: History And Forecast



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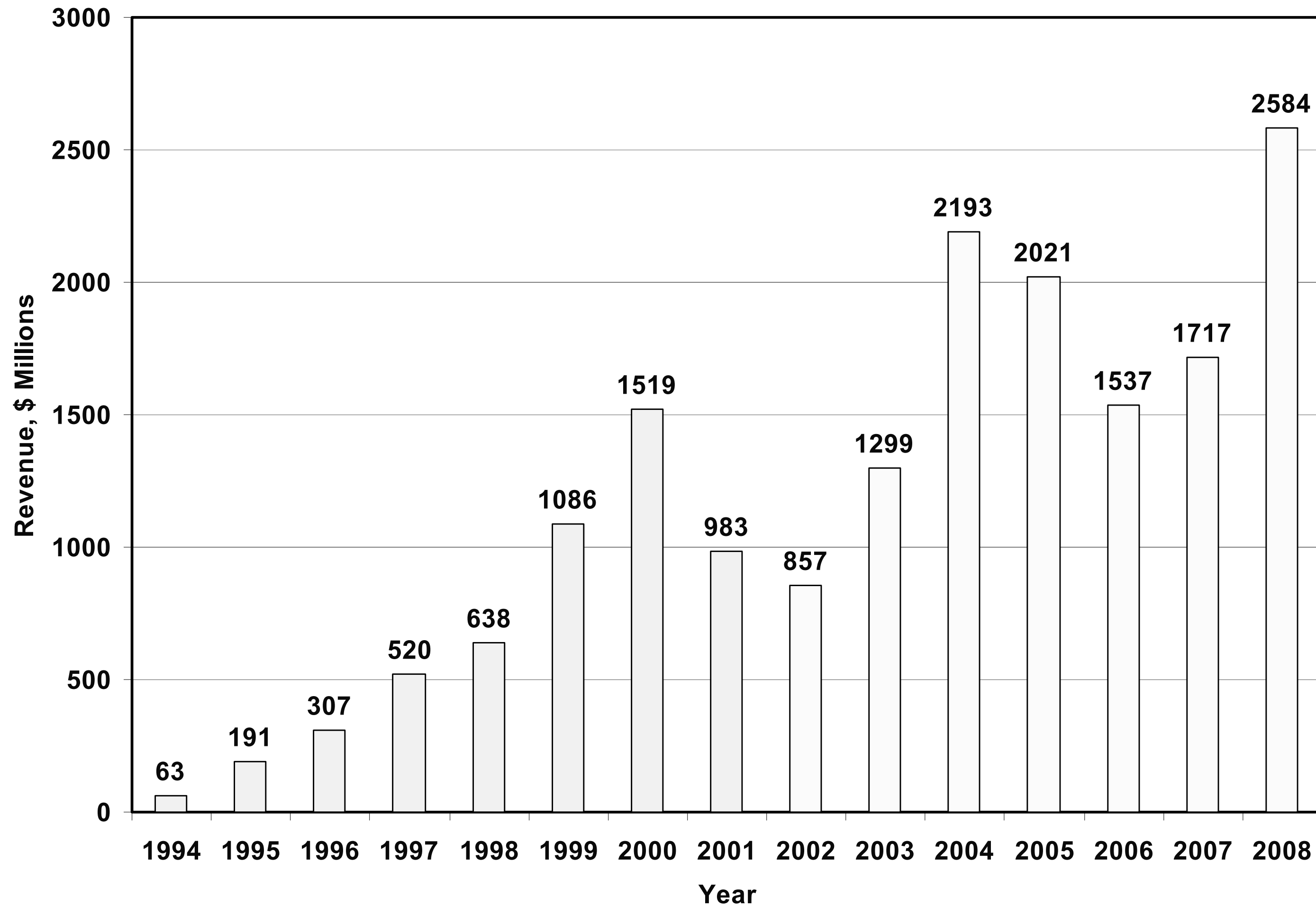
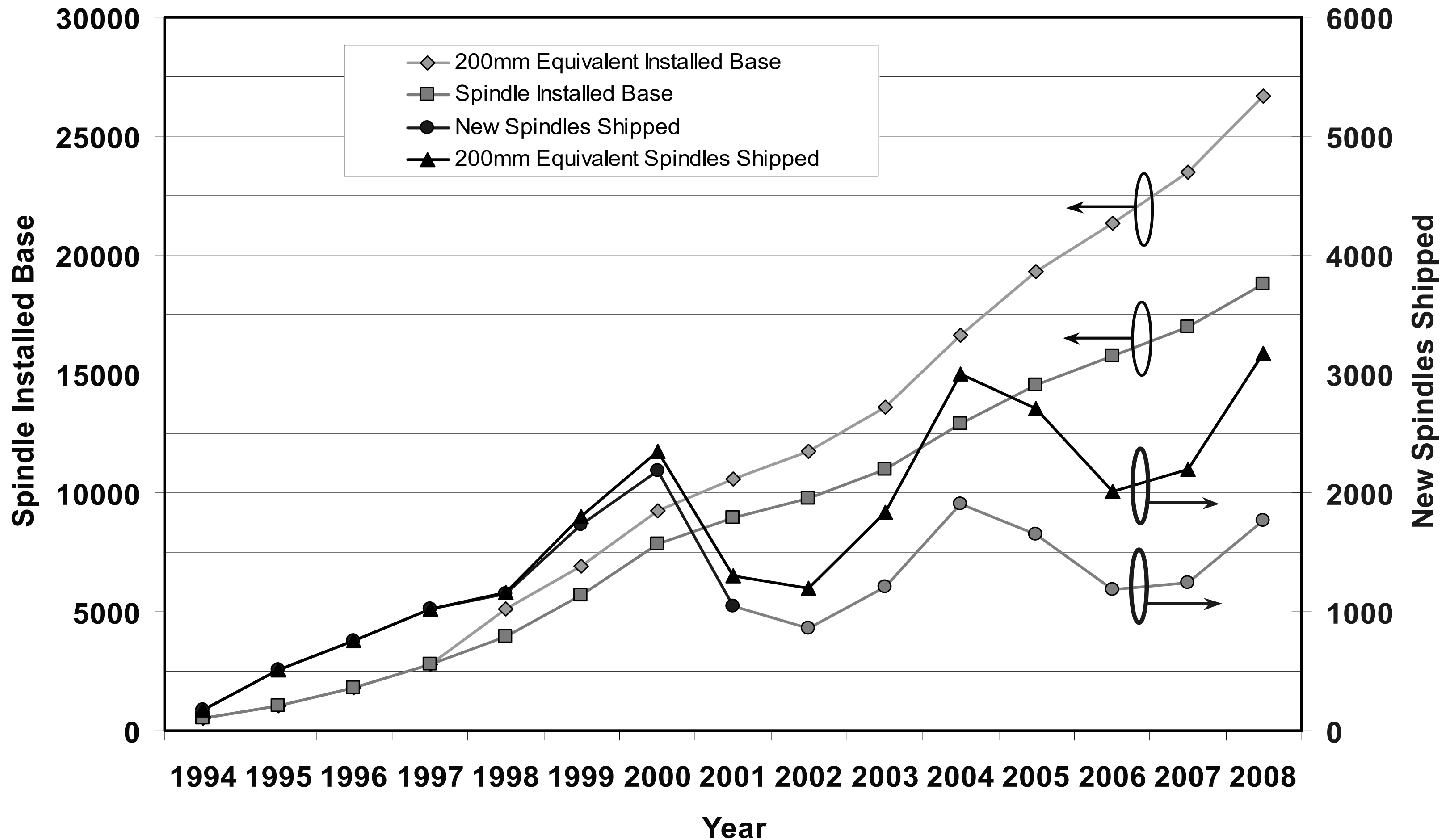
CMP Equipment Markets: 1994-2008



CMP Spindle Shipments And Installed Base: 1994-2008
(With 200mm Spindle Equivalents)



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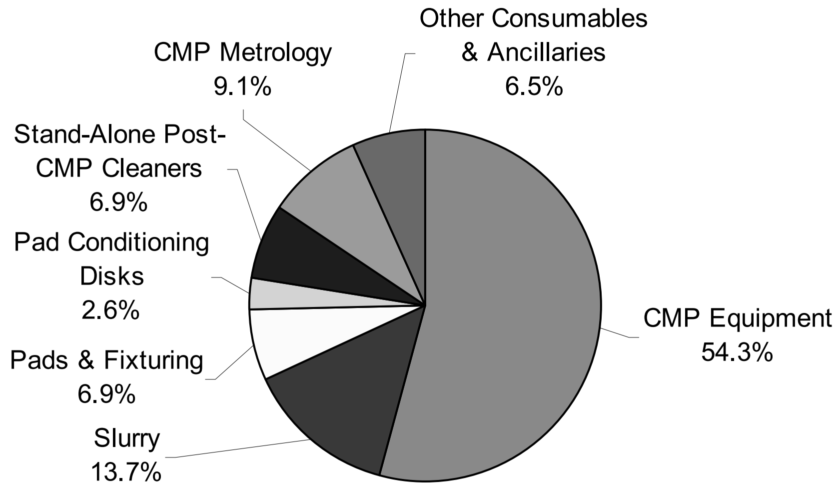
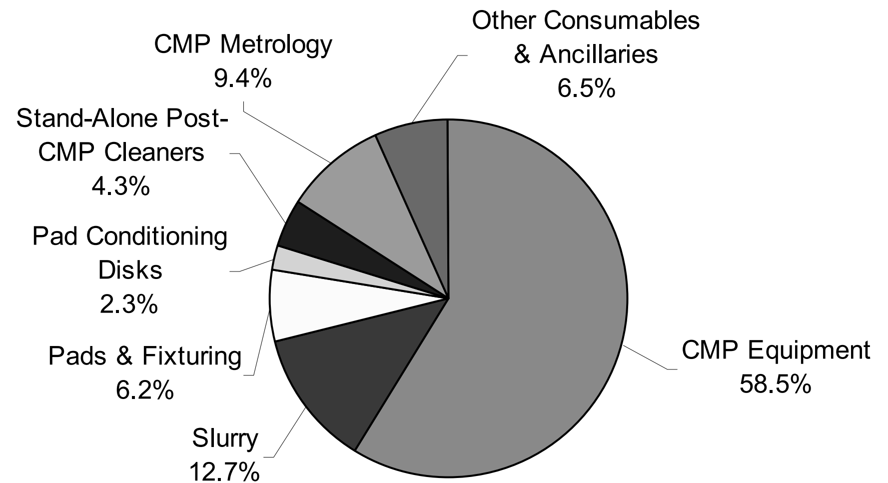
Summary Of CMP Market Segments: 1994 - 2008

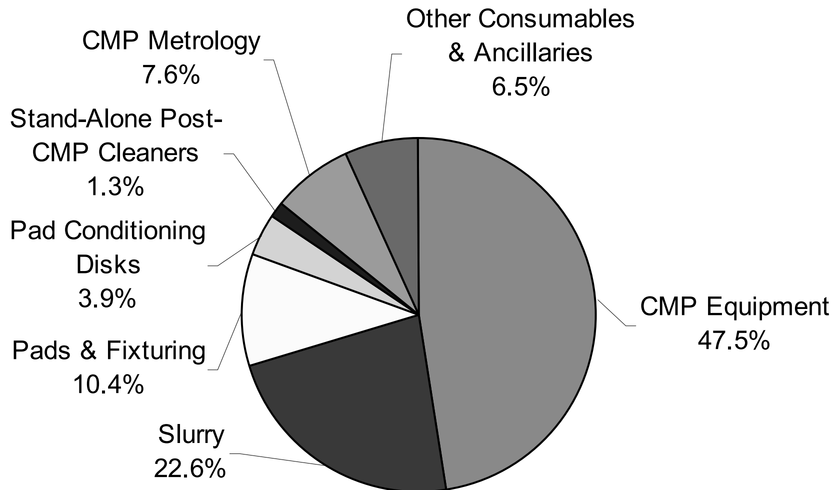
Market Segments, $ Millions	1994	1995	1996	1997	1998	1999	2000	2001	2002
CMP Equipment	63.0	191.3	307.4	520.1	638.4	1085.7	1518.7	982.8	857.0
200mm Cu CMP	-	-	-	26.2	73.3	143.8	154.0	268.3	239.1
300mm Cu CMP	-	-	-	0.0	0.0	8.9	17.0	105.3	178.2
Total Cu CMP	-	-	-	26.2	73.3	152.7	171.1	373.6	417.3
Cu CMP Percent Of Total	-	-	-	5.0%	11.5%	14.1%	11.3%	38.0%	48.7%
Percent 300mm	-	-	-	-	0.9%	4.9%	9.9%	27.9%	42.6%
300mm CMP Equipment Revenue	-	-	-	-	5.6	53.1	150.0	274.3	364.8
Slurry	17.1	39.0	63.7	111.9	160.6	217.1	328.7	330.0	408.1
Pads & Fixturing	6.2	15.2	28.3	53.5	81.5	110.9	160.8	151.4	187.7
Pad Conditioning Disks	2.2	5.6	10.4	19.9	30.3	41.3	59.9	56.8	70.7
Stand-Alone Post-CMP Cleaners	17.7	50.4	76.5	88.0	81.5	101.3	112.5	30.0	24.2
CMP Metrology	12.5	37.5	60.4	88.7	107.2	176.6	243.7	141.3	136.7
Other Consumables & Ancillaries	8.3	23.7	38.3	61.8	77.0	121.3	169.7	118.5	117.9
Total CMP Markets	127.0	362.8	585.0	943.9	1176.6	1854.3	2594.1	1810.7	1802.5

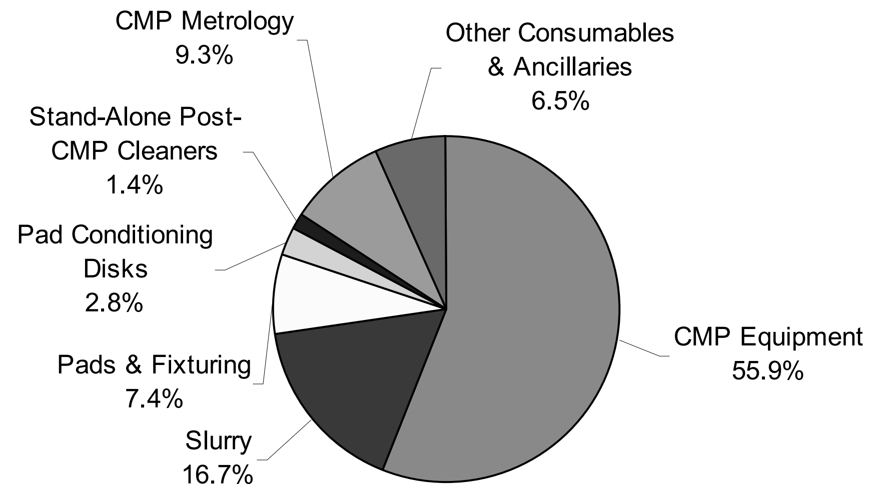
Market Segments, $ Millions	2001	2002	2003	2004	2005	2006	2007	2008
CMP Equipment	982.8	857.0	1298.6	2193.1	2020.6	1536.7	1716.9	2583.9
200mm Cu CMP	268.3	239.1	311.4	458.8	365.3	245.9	254.2	345.3
300mm Cu CMP	105.3	178.2	369.6	702.2	704.0	557.5	678.2	1032.0
Total Cu CMP	373.6	417.3	681.0	1161.0	1069.3	803.4	932.4	1377.3
Cu CMP Percent Of Total	0.4	48.7%	52.4%	52.9%	52.9%	52.3%	54.3%	53.3%
Percent 300mm	0.3	42.6%	54.1%	60.2%	65.8%	69.5%	72.5%	74.9%
300mm CMP Equipment Revenue	274.3	364.8	702.8	1320.8	1329.1	1067.9	1245.4	1935.8
Slurry	330.0	408.1	514.3	653.3	786.1	887.6	966.5	1068.0
Pads & Fixturing	151.4	187.7	238.7	288.8	340.5	370.6	389.4	413.2
Pad Conditioning Disks	56.8	70.7	90.0	110.0	130.7	142.8	150.3	160.8
Stand-Alone Post-CMP Cleaners	30.0	24.2	34.9	55.7	49.6	36.4	40.0	58.4
CMP Metrology	141.3	136.7	210.9	364.7	346.9	272.3	313.3	488.4
Other Consumables & Ancillaries	118.5	117.9	167.1	256.6	257.2	227.2	250.3	334.1
Total CMP Markets	1810.7	1802.5	2554.5	3922.1	3931.5	3473.6	3826.7	5106.7

Distribution Of CMP Revenues By Segment

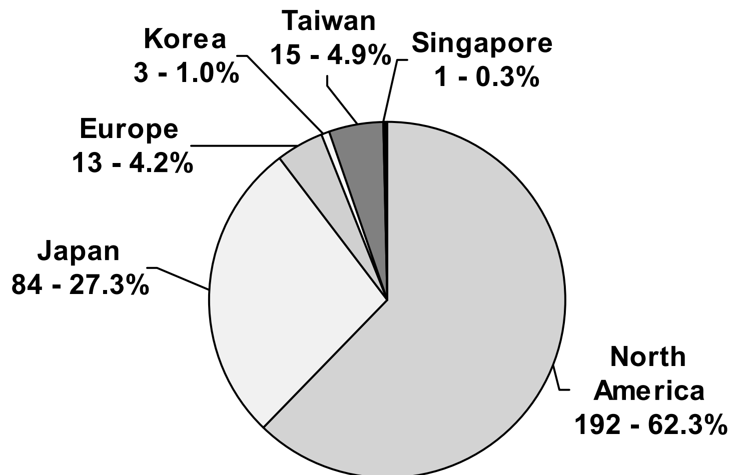


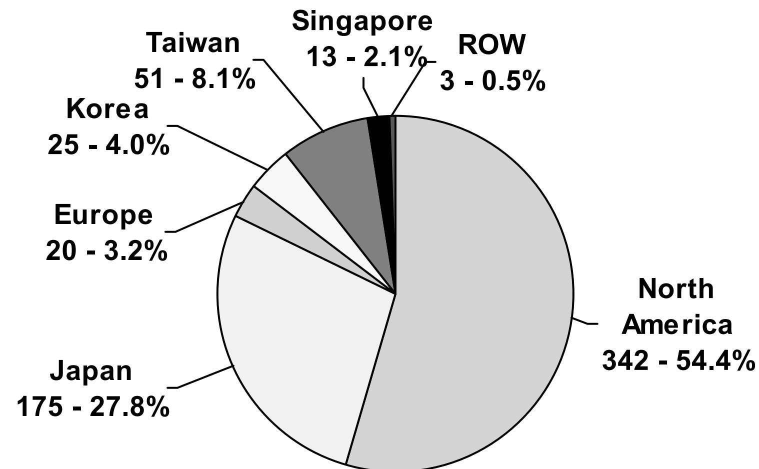


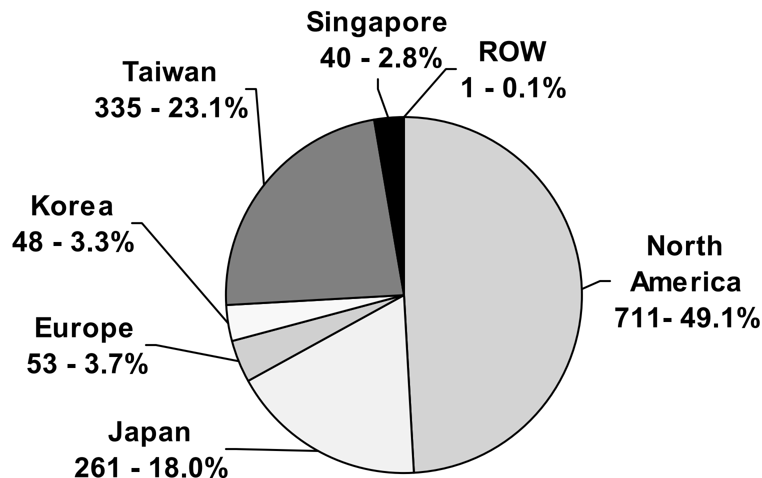


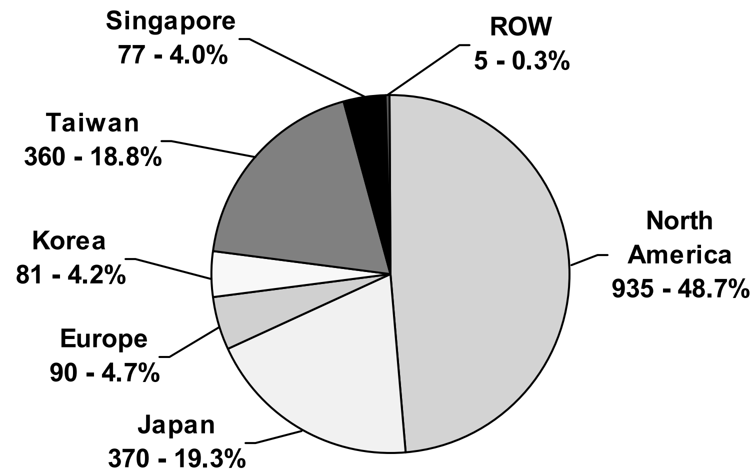


US CMP Related Patents Issued By Geographic Region Of Assignee









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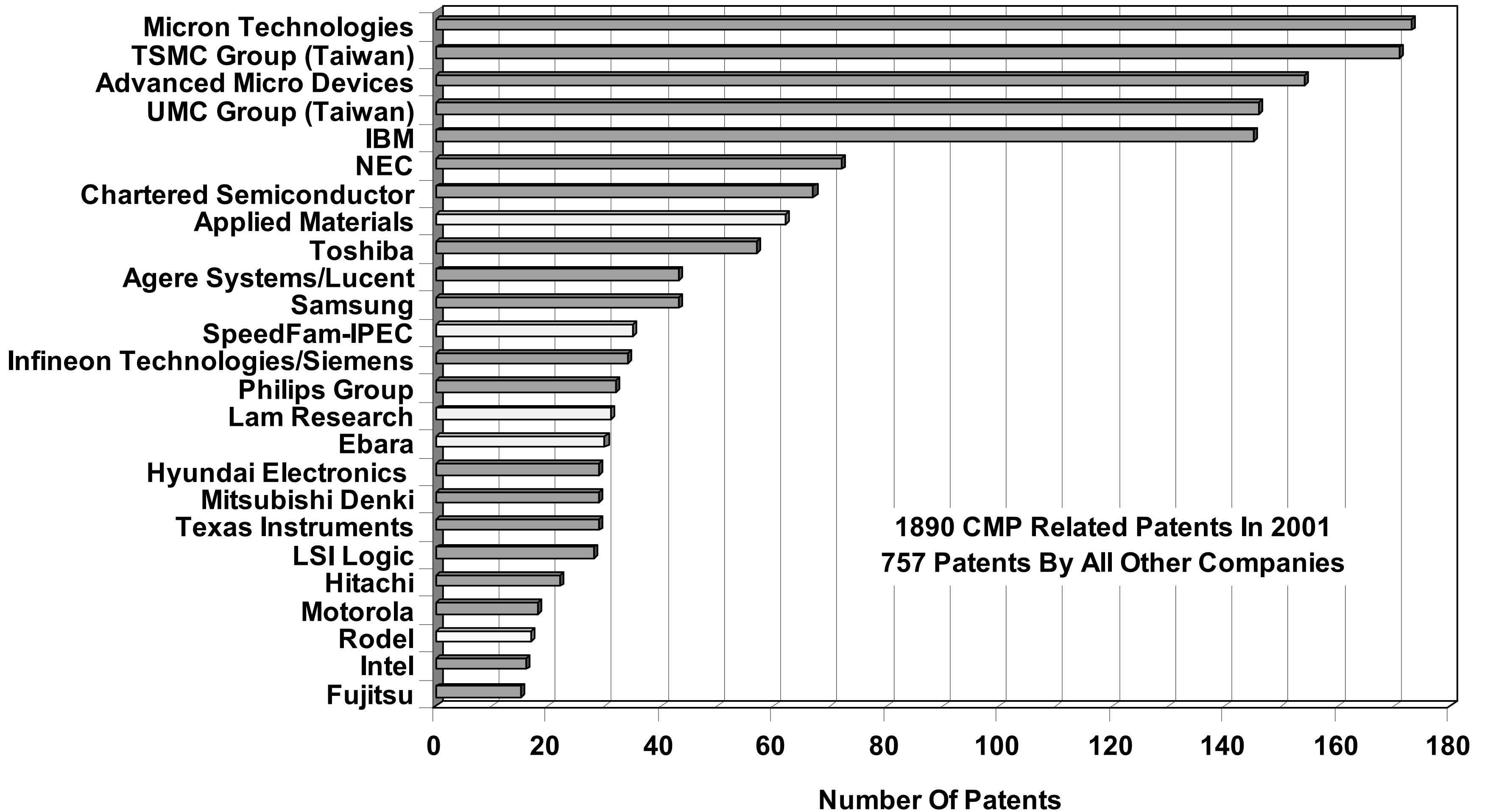
2001 US CMP Related Patents By Company



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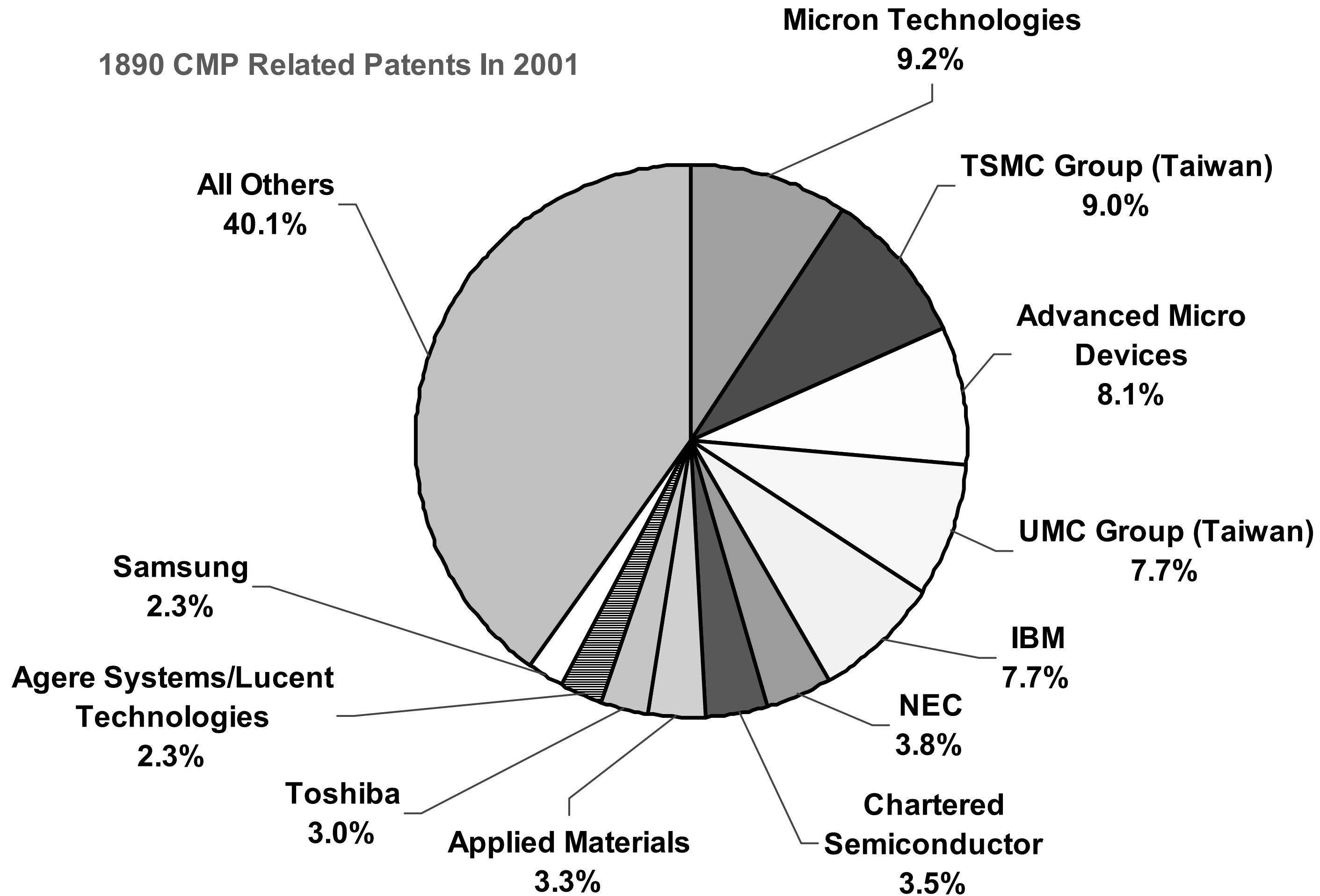
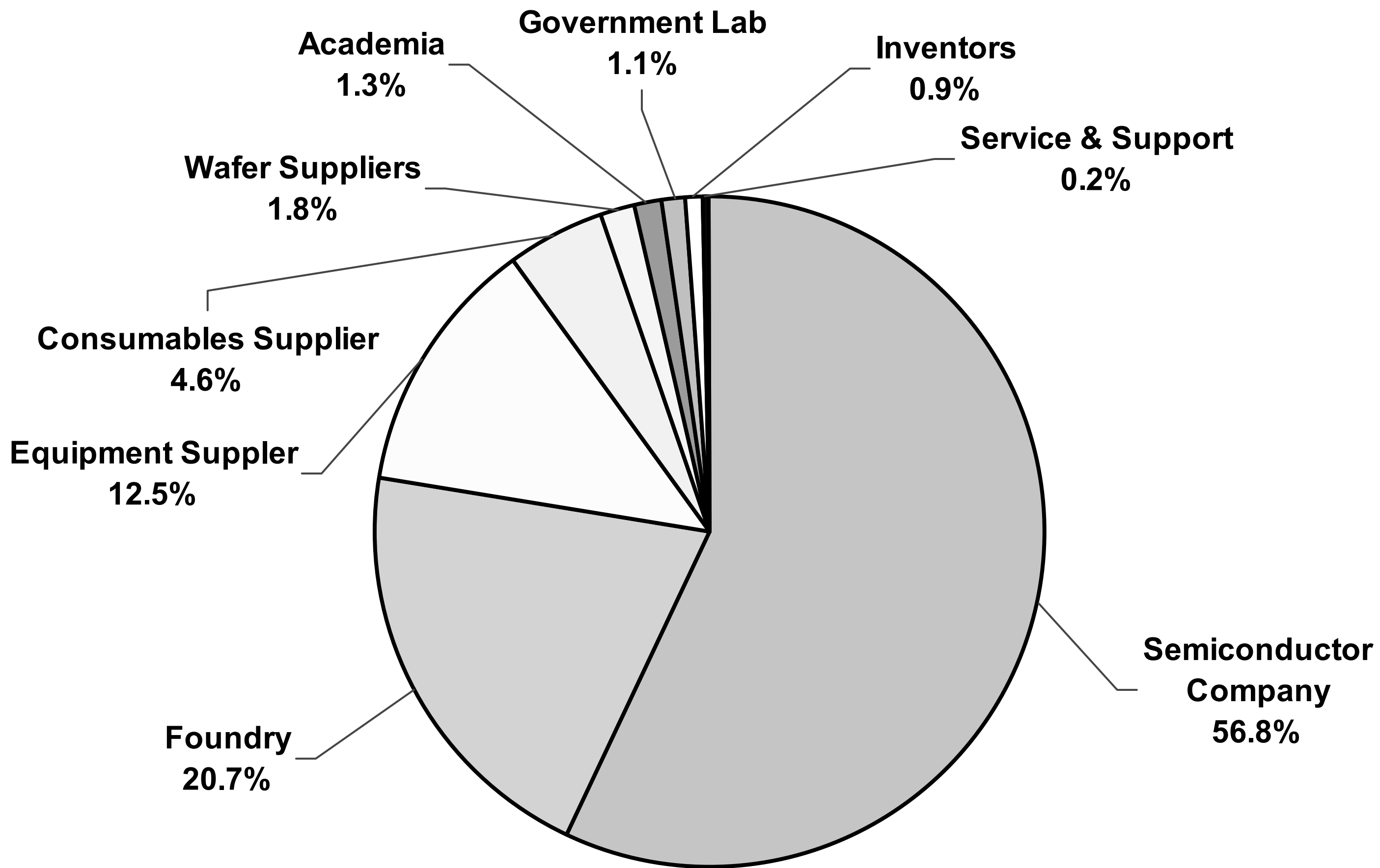
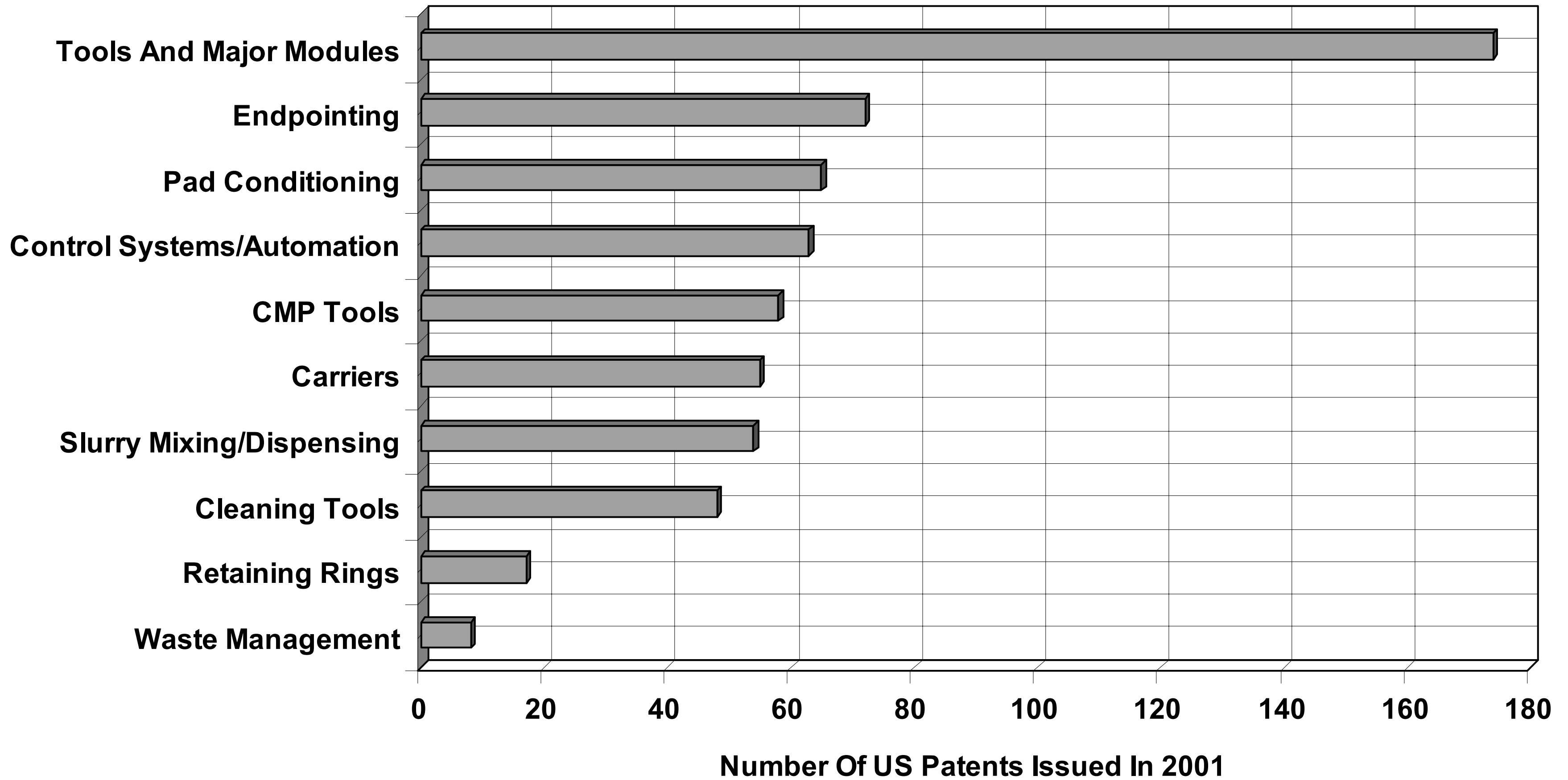
Distribution Of 2001 CMP Patents



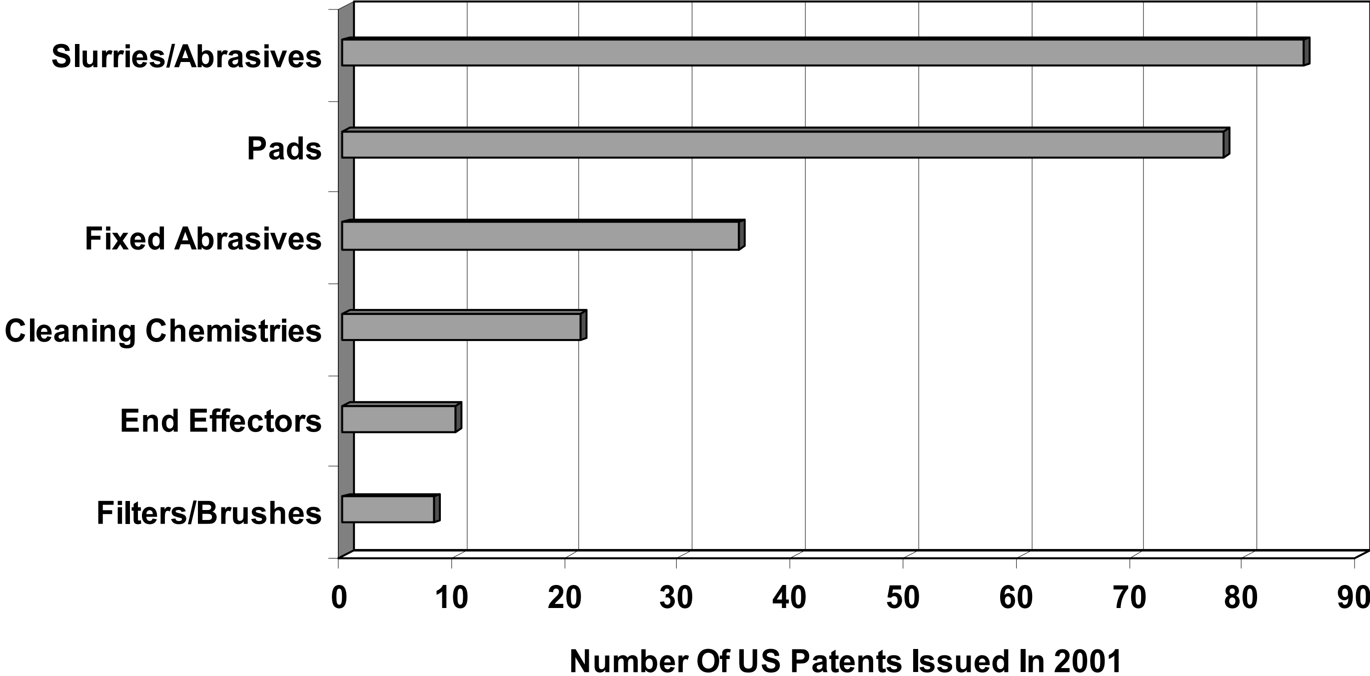
US CMP Related Patents Issued In 2001 By Type Of Assignee



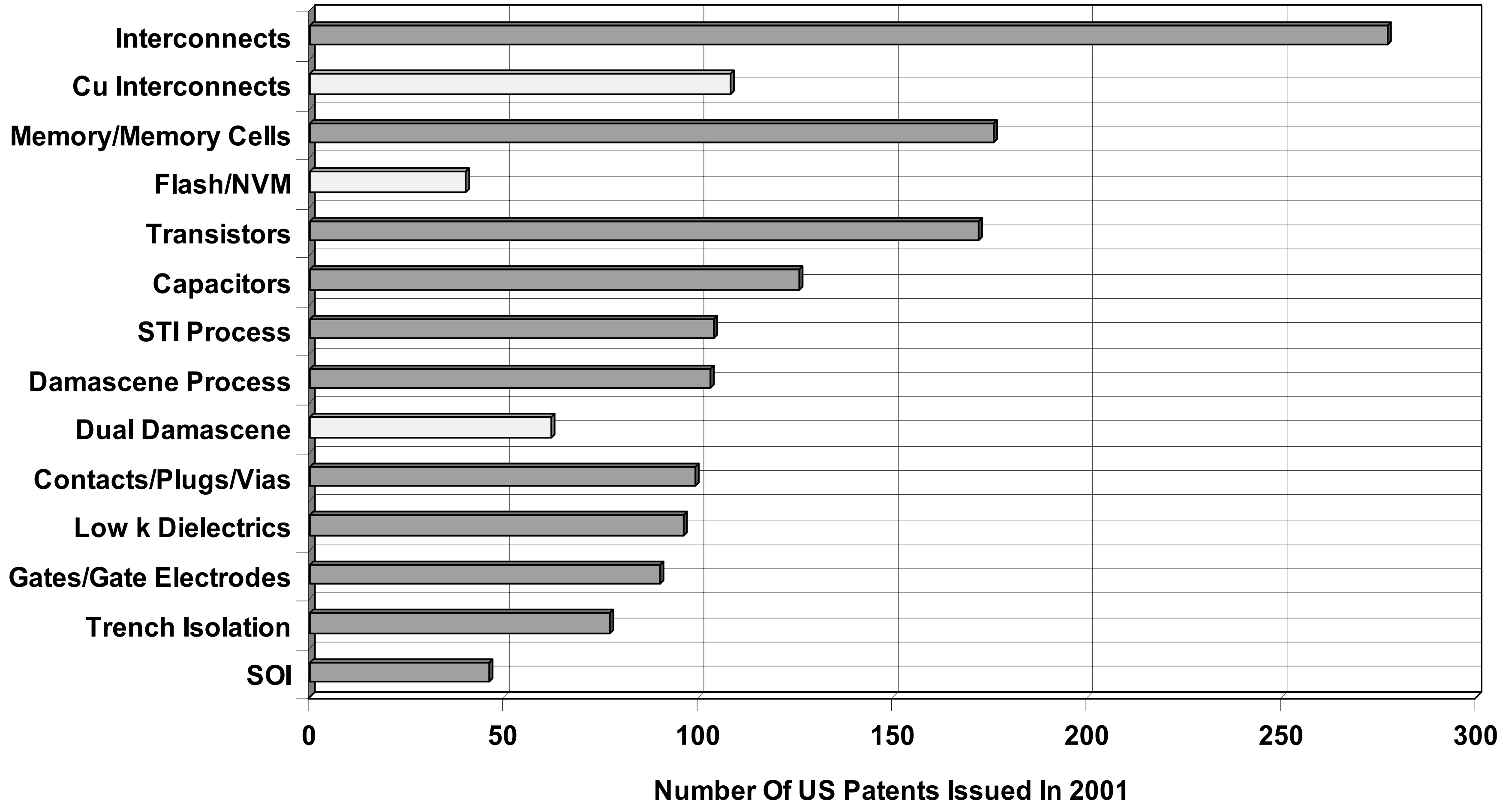
CMP Related Apparatus Patents



CMP Related Consumables Patents



CMP Related Process Patents



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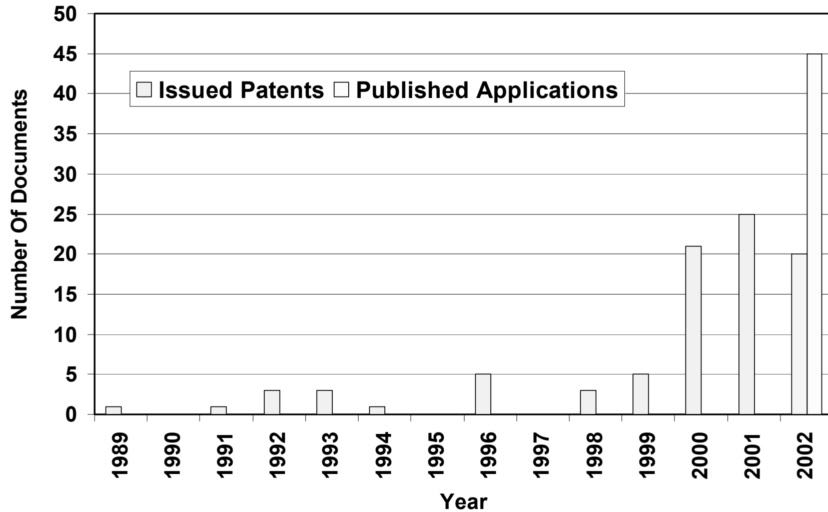
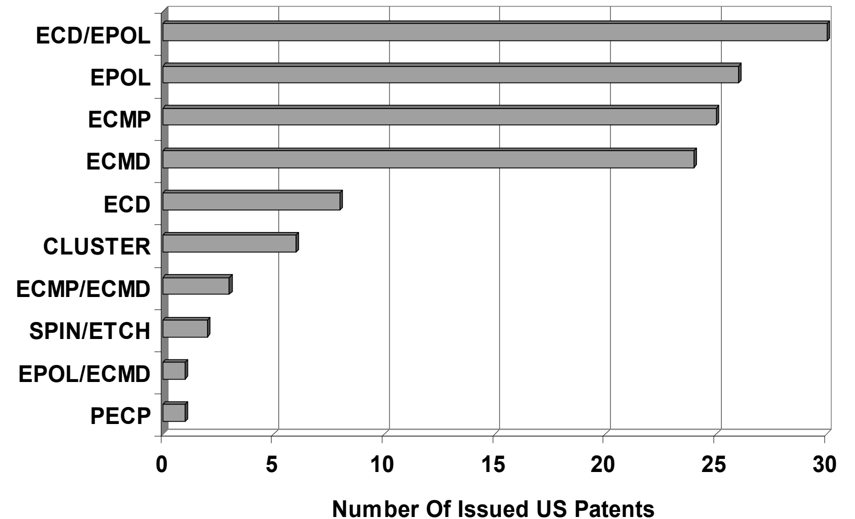
Electrolytic Processes Used For Planarization





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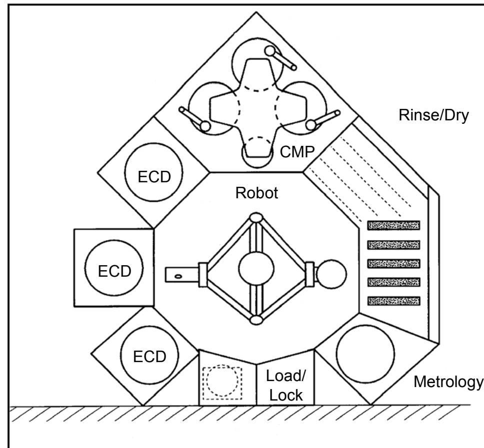
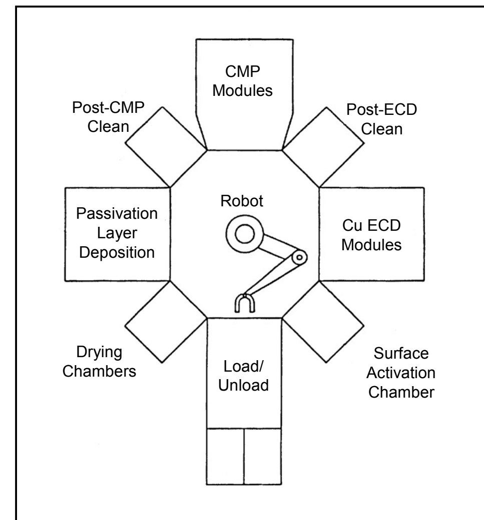
Cluster Tool Approach – Copper Metallization Module

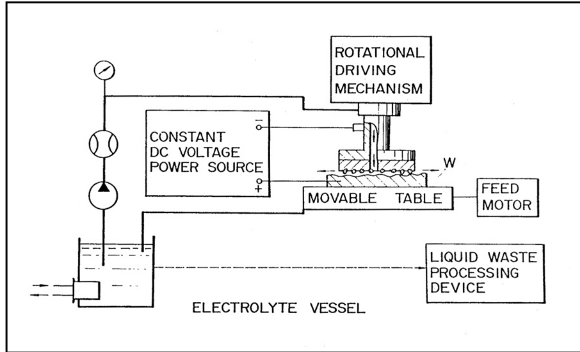


Applied Materials Concept

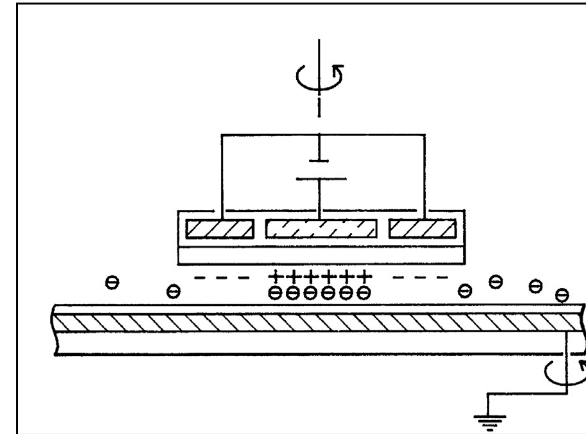


Ebara Concept

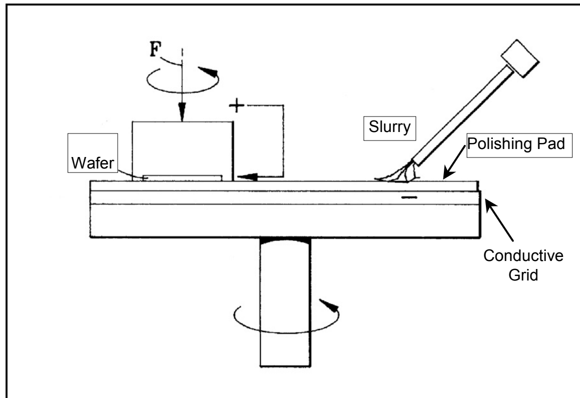
Electrolytically Assisted CMP



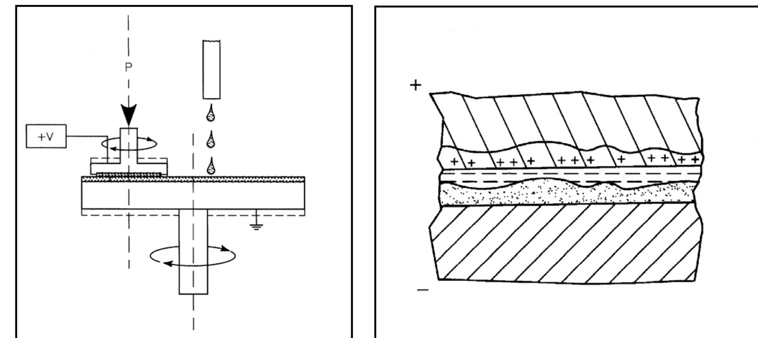
Kobe Seiko US patent 4839005
issued on June 13, 1989



TSMC US patent 5575706
issued November 19, 1996



IBM US patent 5807165 issued
on September 15, 1998



Micron Technology US patent 6010964
issued on January 4, 2000

CMP Tool Generations

Tool Generation	Time Period	Wafer Size, mm	Kinematics	Throughput, wph	Carrier Technology	Tool Process Capability	Metrology
1	1984-1994	100-200	Rotary	10	Fixed Plate	Dry-In Wet-Out 1 Step CMP + Buff Clean Single Wafer 10mm Edge Exclusion	Motor Current EPD
2	1993-1999	125-200	Rotary Orbital Carousel	20	Fixed Plate Back Pressure Active Retaining Ring	Dry-In Wet-Out 1 Step CMP + Buff Clean Multiple Wafers 6mm Edge Exclusion	Motor Current EPD In Line Optical Metrology
3	1998-2003	200-300	Rotary Orbital Linear	35	Active Retaining Ring Membrane Backing	Dry-In Dry-Out Multiple Step+Buff Clean Multiple Wafers 3mm Edge Exclusion	In Line Optical Metrology Run-To-Run Control In-situ Optical EPD Acoustic Monitor EPD Chemiluminescence EPD
4	2001-	200-300	Rotary Orbital Linear Elliptical	50	Active Retaining Ring Membrane Backing Zone Pressure Control	Dry-In Dry-Out Multiple Step+Buff Clean Multiple Wafers ≤2mm Edge Exclusion	In Line Optical Metrology Adaptive Process Control Coefficient Of Friction EPD In-situ Optical EPD Acoustic Emission EPD Chemiluminescence EPD Eddy Current EPD
5	2003-	300	Rotary Orbital Linear Elliptical	50	Active Retaining Ring Membrane Backing Zone Pressure Control	Dry-In Dry-Out Multiple Step+Buff Clean Multiple Wafers ≤2mm Edge Exclusion Integration With Electroplating Module And Rapid Thermal Anneal Electrically Enhanced CMP	In Line Optical Metrology Adaptive Process Control Coefficient Of Friction EPD In-situ Optical EPD Acoustic Emission EPD Chemiluminescence EPD Eddy Current EPD

Conclusions

- CMP Market Segments Have Been Severely Impacted During The Current Downturn
- Consumables Segments And Leading Edge Technology Have Been Impacted By The Downturn To A Lesser Degree
- Market Share Rankings Remained Unchanged During 2001
- CMP Market Segments Will Grow At The Same Rate As The Overall Equipment Market Going Forward
- Growth Rates For Semiconductor Revenues Are Slowing While Technology Becomes More Complex And Challenging
- ECMP, ECD or Electropolishing Technologies Have The Potential To Reshape The Equipment And Consumables Markets For Planarization Of Advanced Interconnect Structures