COLLABORATION STRATEGIES FOR SUCCESS

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REVIEW OF COLLABORATION IN LITERATURE

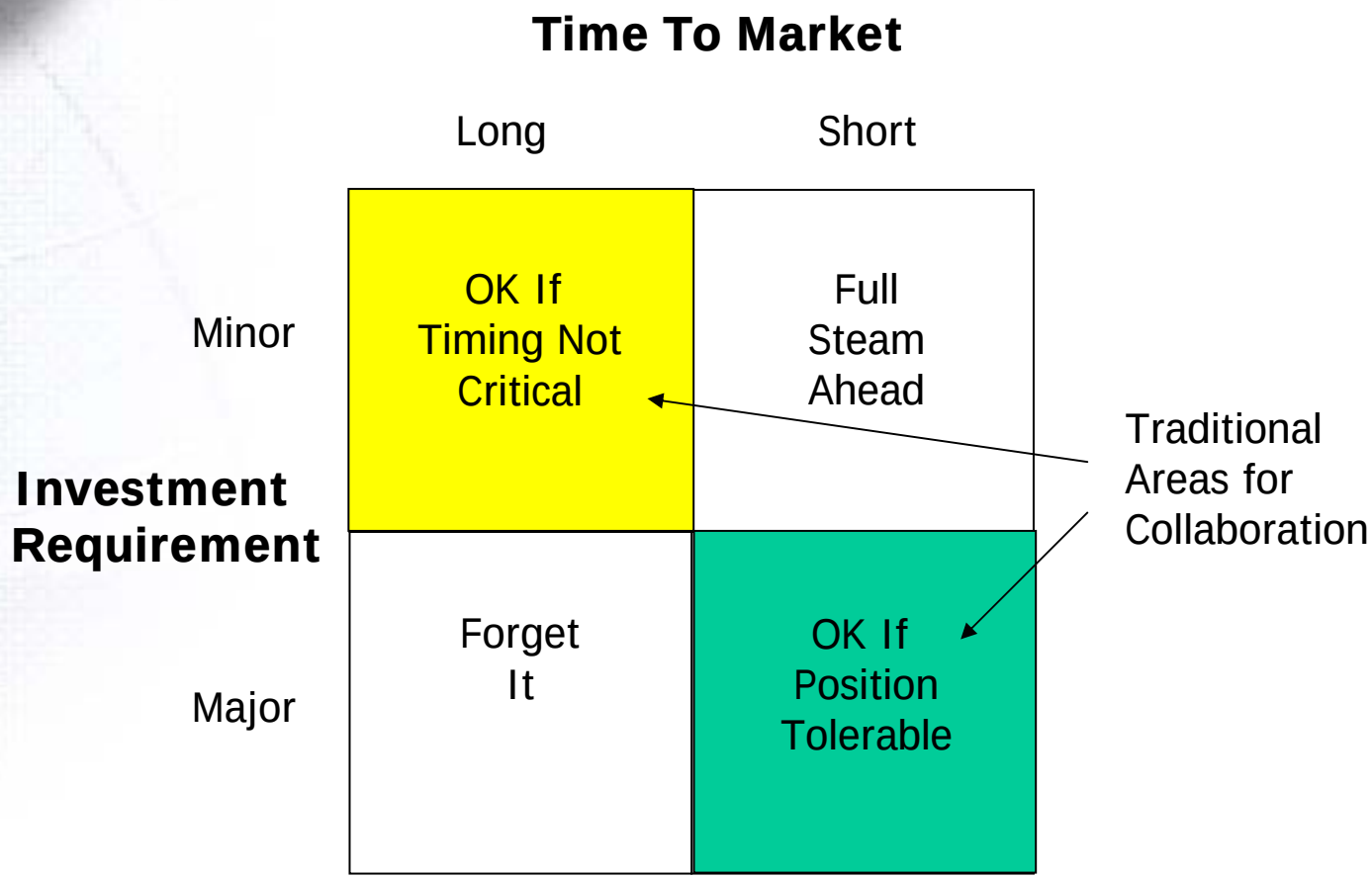
- Jassawalla and Sashittal:
  - **Collaboration is the next step beyond integration and cross functional product development.**
  - Collaboration succeeds when:
    - There is an equal stake in outcomes
    - There is an absence of hidden agendas
    - Participants are willing to accept difference
    - "The (collaboration) exceeds the sum of the capabilities of the individual participants"

- IBM and EIU Survey of CEOs
  - "Product / service / market innovation have become table stakes in the competitive game."
  - The second most common business growth model amongst innovators is ***Major Strategic Partnerships***

COLLABORATIVE R&D MODELS

- Increased R&D is only sustainable if it leads to a larger slice of the revenue pie.
  - This has happened with OEMs
  - This has not happened in materials
- Automotive model:
  - Materials suppliers become tier 2/3 suppliers, integrated with tier 1 suppliers in tight strategic collaborations
- Current Semiconductor models:
  - Industry / Government funded R&D
    - Sematech, or Selete develops pre-competitive IP and grants rights to materials makers
  - Industry / Government collaborative groups that share resources and cost
    - SilkNet, CASMAT

INVESTMENT AND TIMING DRIVEN MODEL OF COLLABORATION

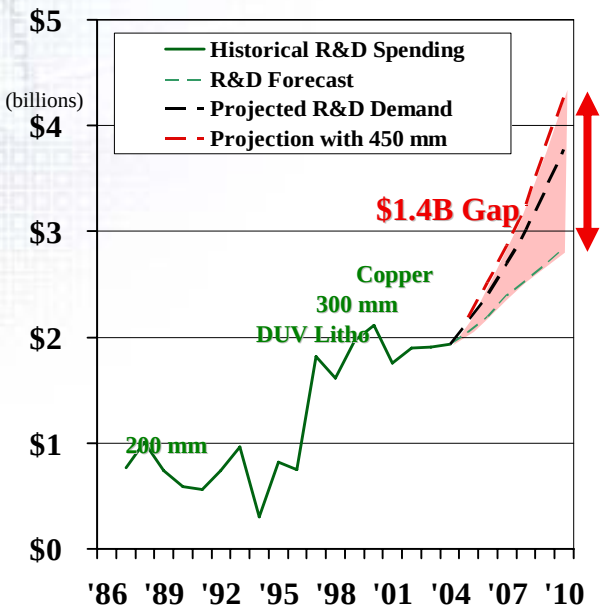


After D. J. Preece

WHY COLLABORATE IN SEMICONDUCTOR MATERIALS?

- The semiconductor industry's unique material requirements drive a heavy R&D commitment with virtually no leverage to other industries.
- New materials have very long adoption cycles and a very slow ROI on invested R&D.
- Pricing materials to value will strengthen margins and enable more investment in R&D.
- Materials companies need more effective shared lab resources for integration and testing.

Materials R&D Funding Gap



- Historical R&D has been flat since 2000 peak
- Cumulative shortfall over 5 years will be $2.6B
- Next substrate (450 mm ?) will drive up demand further
  - Adds another $1.5B cumulative R&D demand

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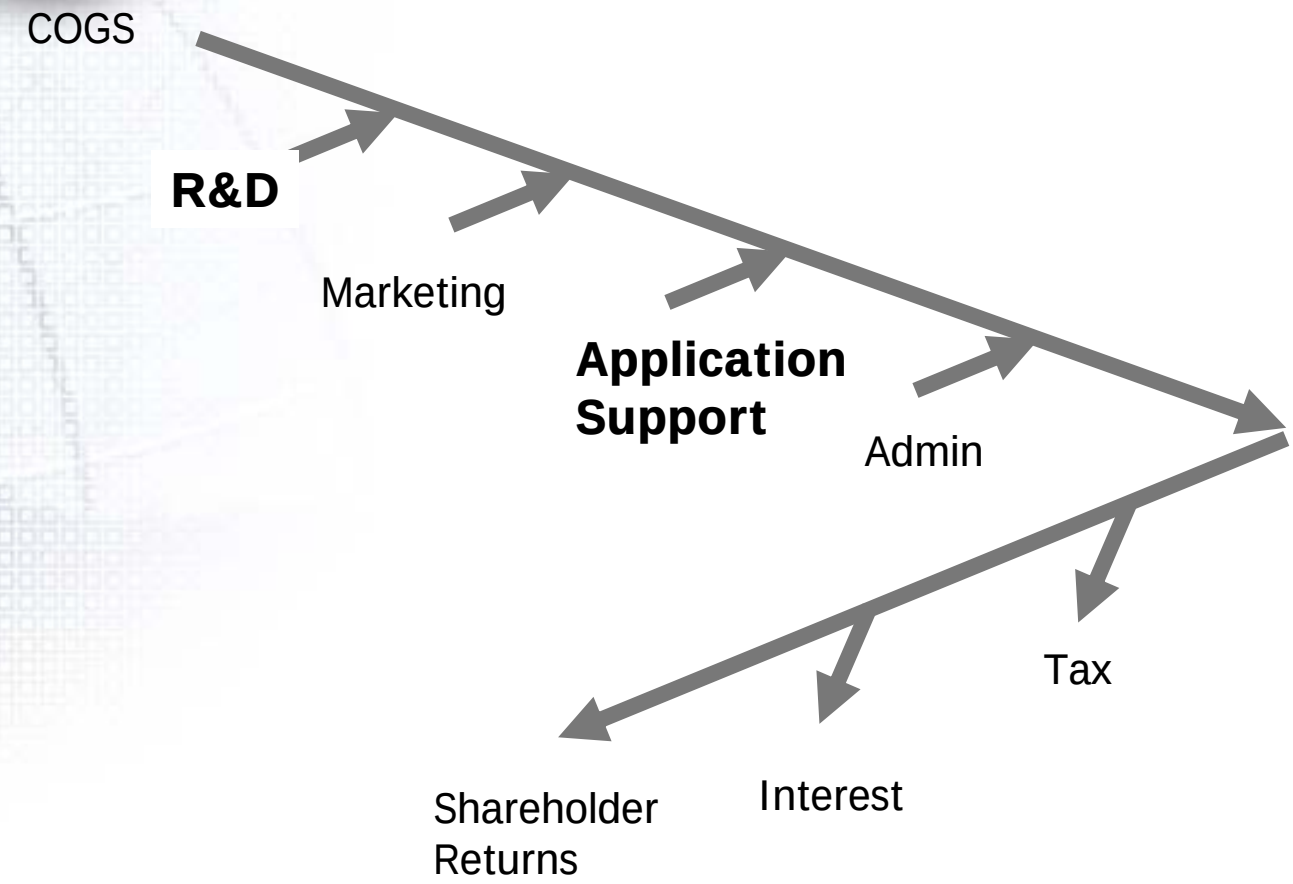
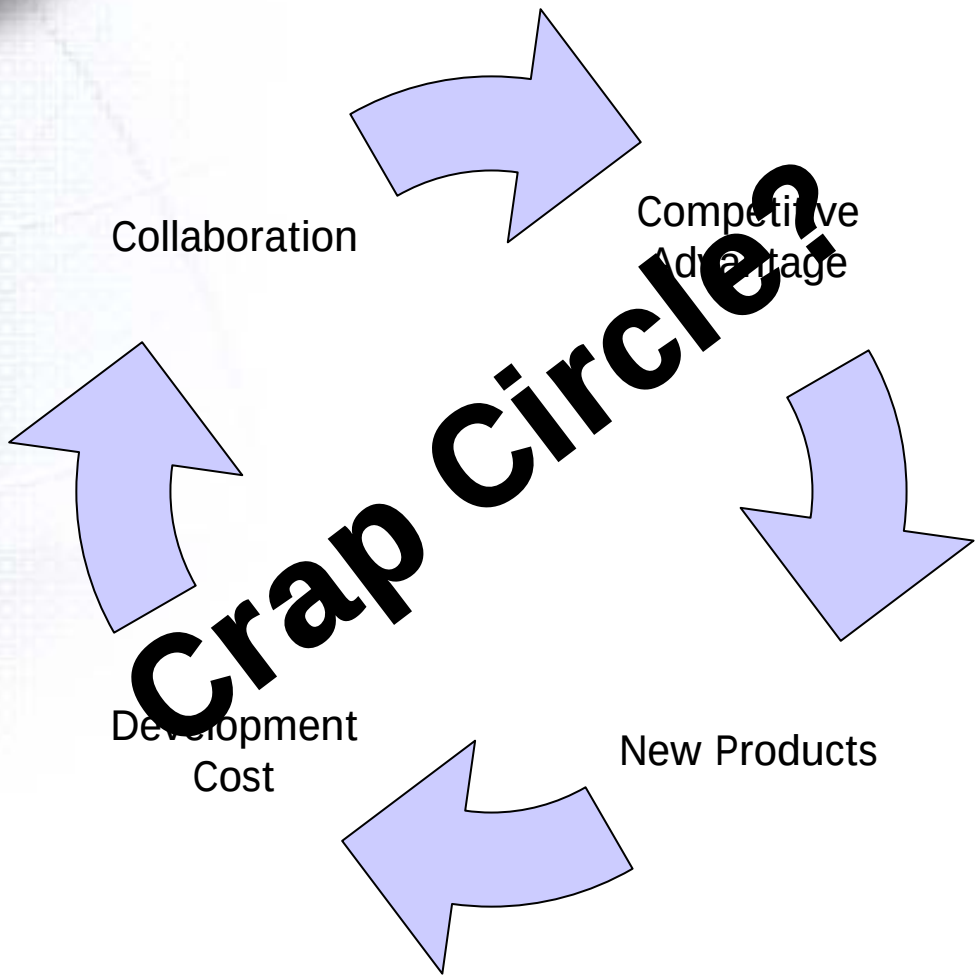
PRODUCT AND SERVICE DIFFERENTIATION



1. **Strong or Novel Products & Services**
2. **Increased Market Share**

TRADITIONAL VIEW OF COLLABORATION



Development Cost

=

R&D Direct Cost

+

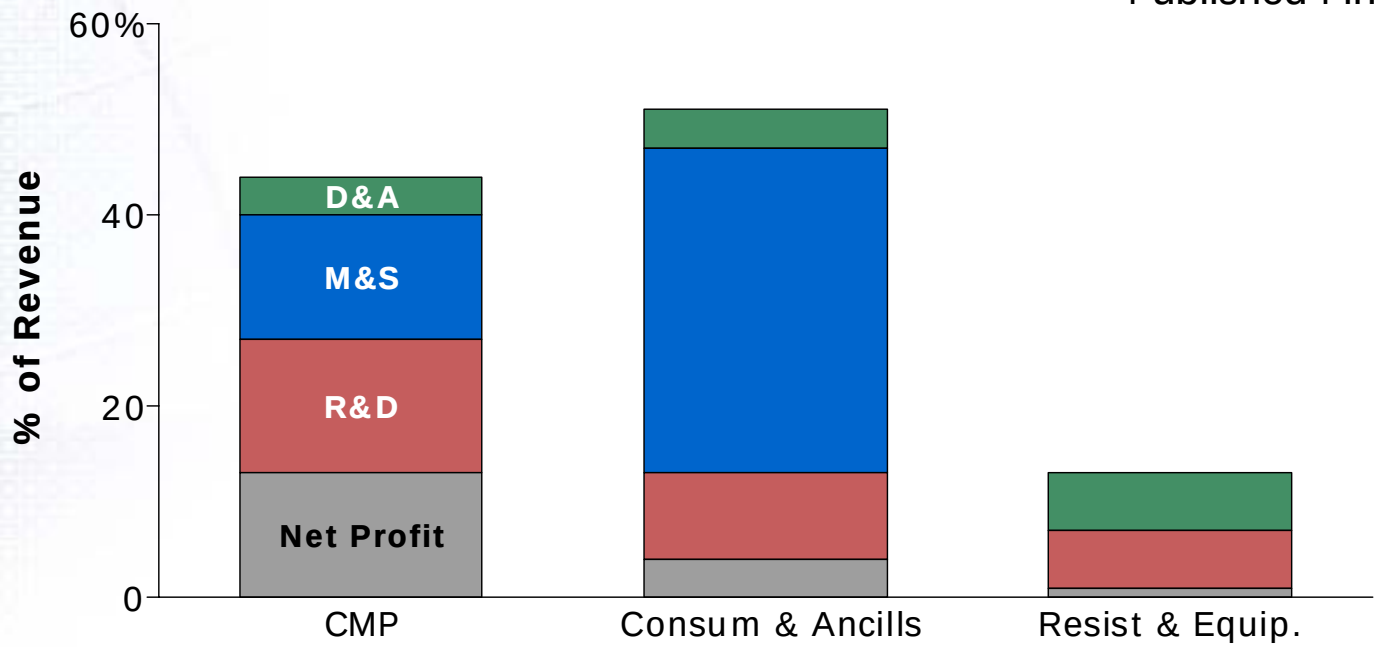
R&D Depreciation

+

Application Cost

DIFFERING PRODUCT COST STRUCTURES BY SEGMENT

Average of Last 4 Years of Published Financial Results



Combined R&D, Marketing and Depreciation varies from 12% to 48%

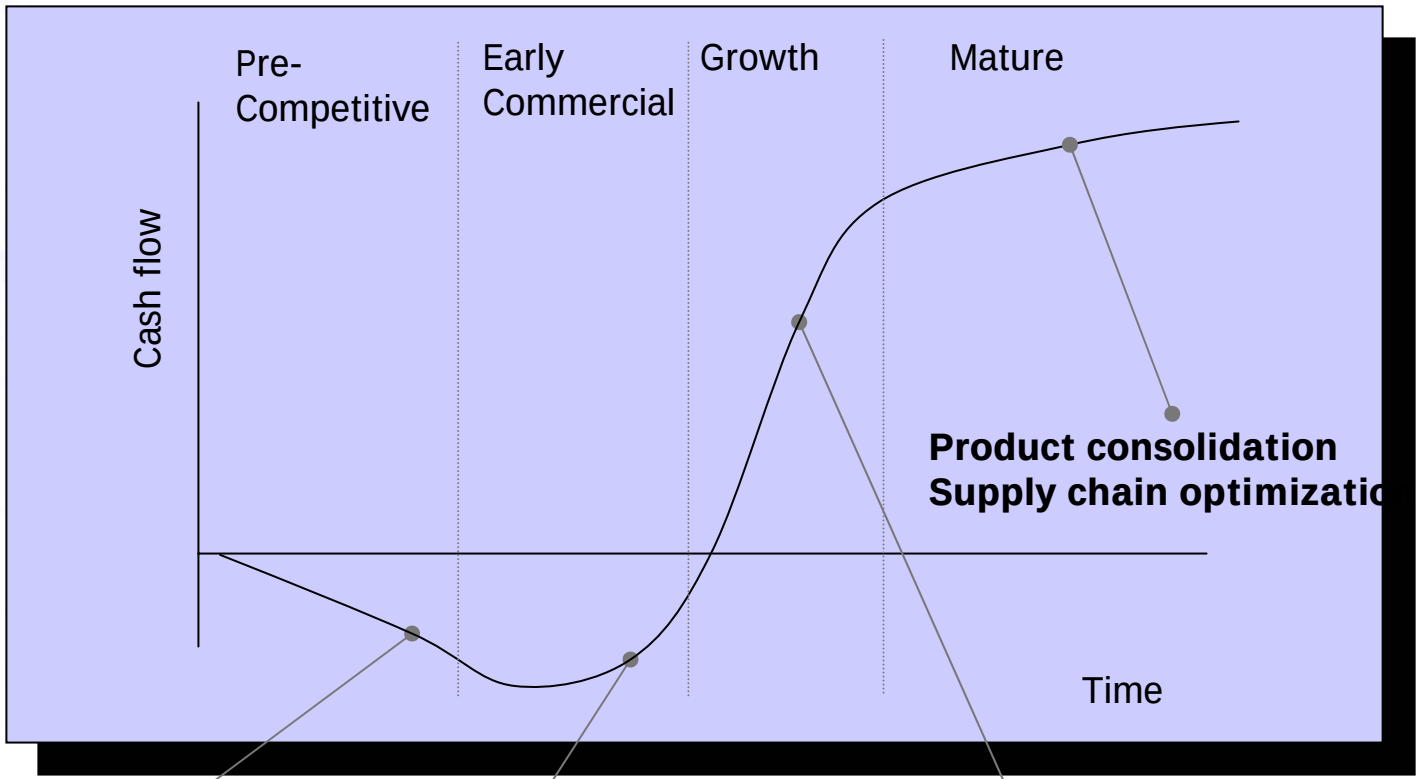
COLLABORATION TYPES

1. Pre-competitive
   a) Pre Revenue: high cost, single or multi partner, limited lifetime.
   b) Novel / Revolutionary processes.

2. Growth
   – Short Cycle Reformulation. Supporting multiple formulations and evaluations with customers. Learning used in product optimization and marketing.
   – Market Penetration. Lots of application support to develop market share.
   – Manufacturing collaboration due to capacity, IP, or competence limitations.

3. Maturity
   – Optimization of cost structure. Support product consolidation efforts, or further market penetration.

THE COLLABORATION LIFECYCLE



Consortia
Joint Development
Universities

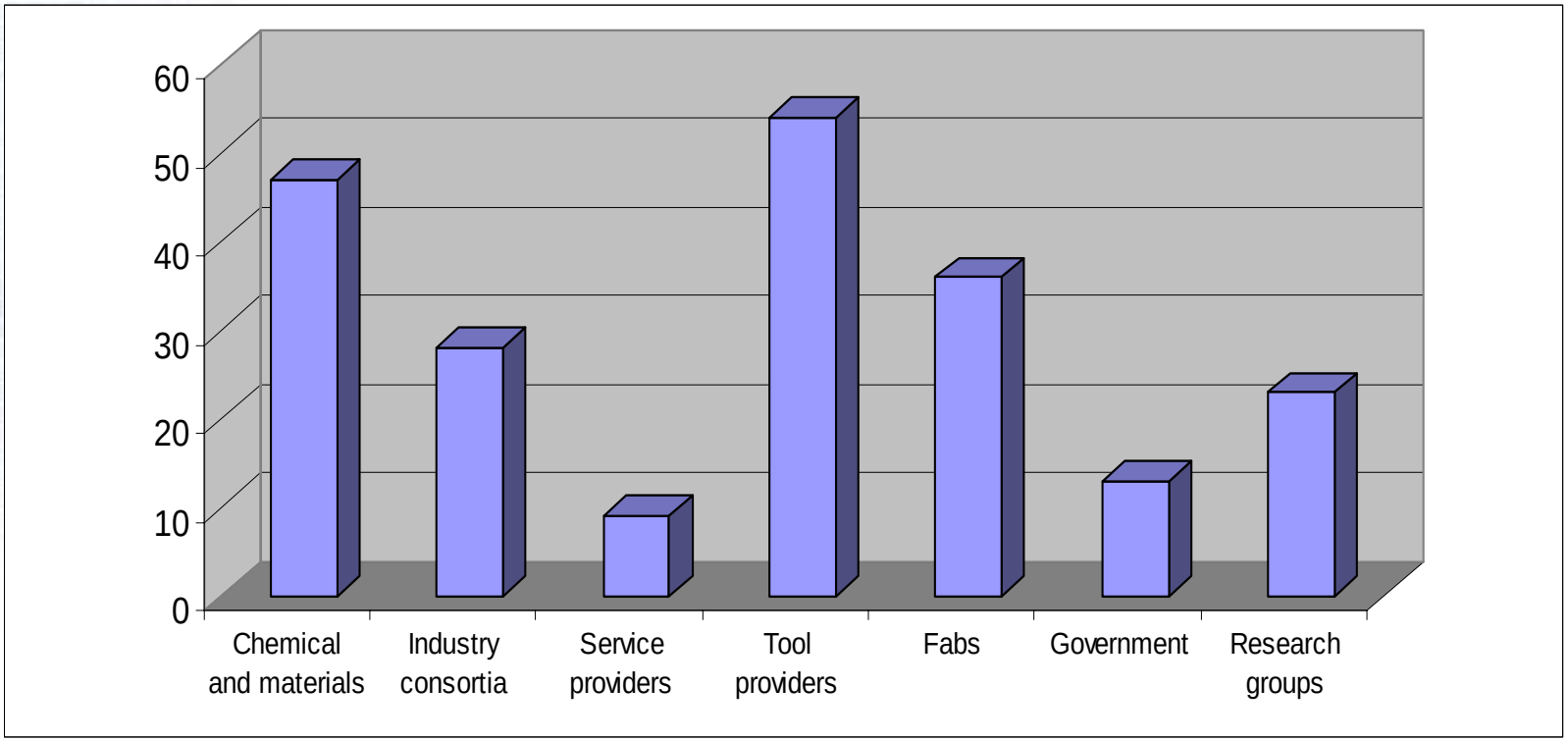
Joint Development

Quick turn product optimization

- **Focus on More Moore, not More than Moore**
- **Focus on Materials**

CANDIDATES FOR MATERIALS COLLABORATION

Number of existing partnerships and alliances – all respondents

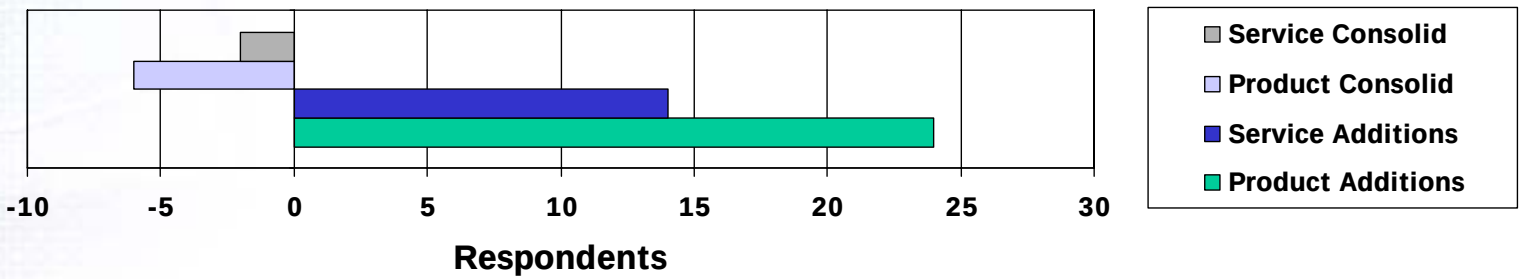


Linx Consulting, SMC 2006

PREVIOUS STUDY RESULTS

- Electronic materials companies focus strongly on new product development and increasing service levels.

- In 2005 there was a **129%** increase in collaborative programs.



- On average there are **6.67 collaboration programs per company**, of which **59%** are focused on new technologies or new markets.

Linx Consulting, SMC 2006

DRIVERS FOR SHARED USE FACILITIES

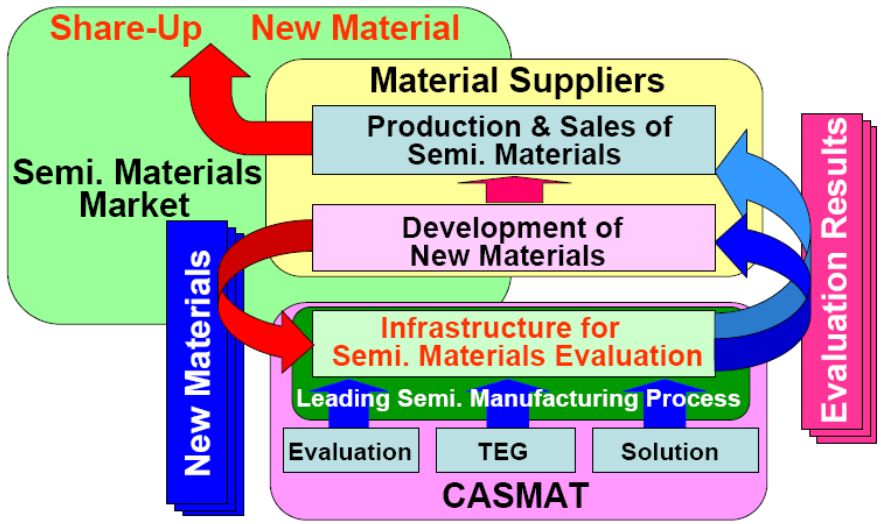
- Customers are unwilling to accept untested products.
- Short loop optimization needs to take place in a secure, state of the art facility.
- Cost of the facility is often disproportionate with materials revenue available:
  - PVD tool $5m
  - Target $10k
- Some materials require testing of integration capability, compounding cost and technical complexity.
- A possible solution to Pre-Competitive and Early Commercialization phases is a shared use facility for material suppliers.

SHARED USE FACILITY

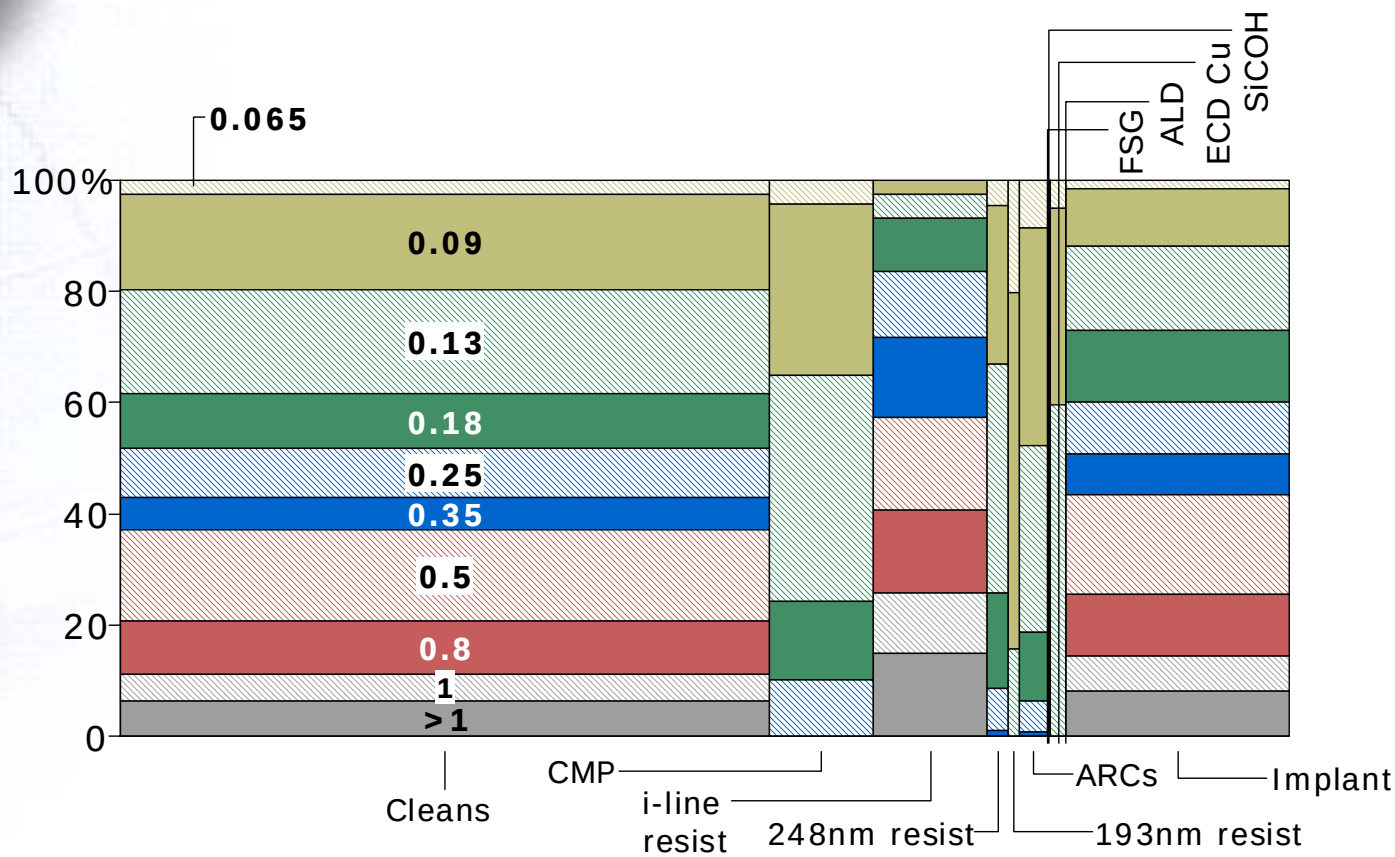
- A successful example is CASMAT in Japan.
- Attempts to develop a US based shared use facility have failed several times due to:
  - IP issues
  - Lack of willingness to invest
  - Concern over operating structure

- SEMI centered efforts foundered in 2006 due to:
  - Materials and Equipment supplier inclusion
  - Funding of initial business studies

CASMAT Conceptual Structure

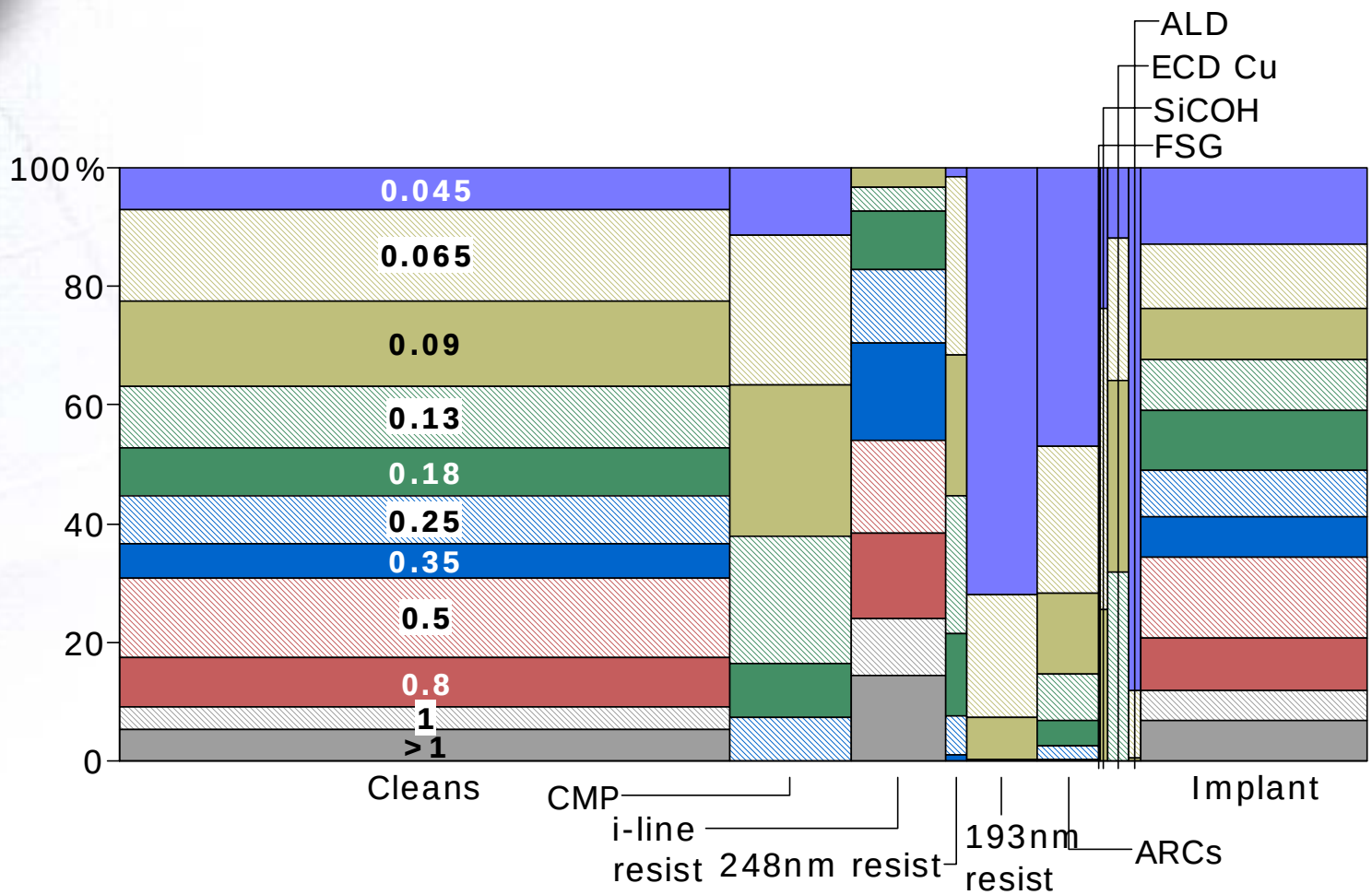


SELECT DEVICE MAKING UNIT OPERATIONS - 2006



Source: Linx Consulting

. . . AND IN 2010

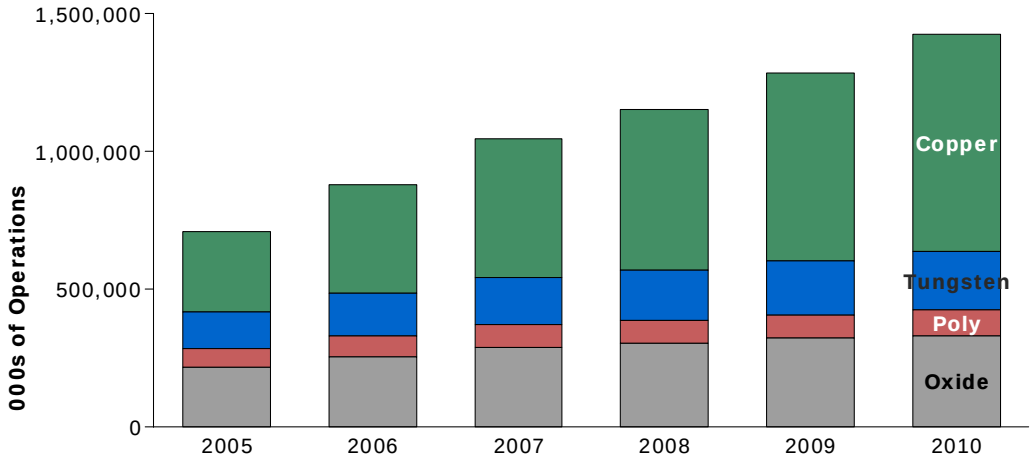


Approximately 40% increase in Unit Operations over 2006

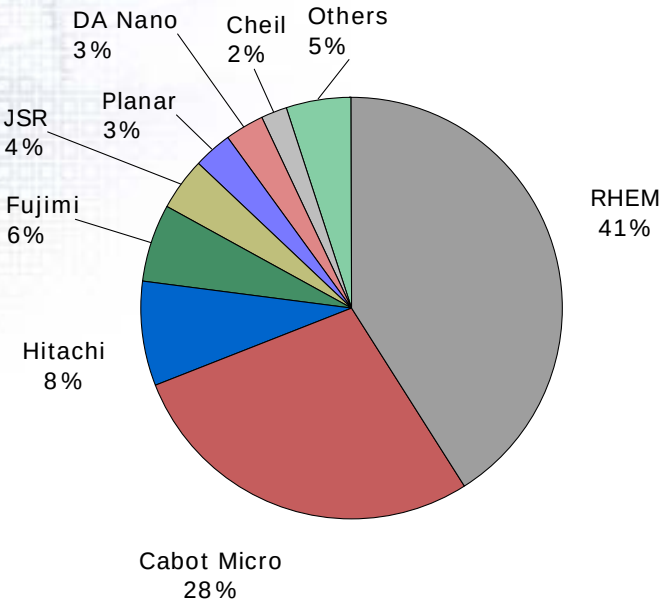
CMP COMSUMABLE MARKET OVERVIEW

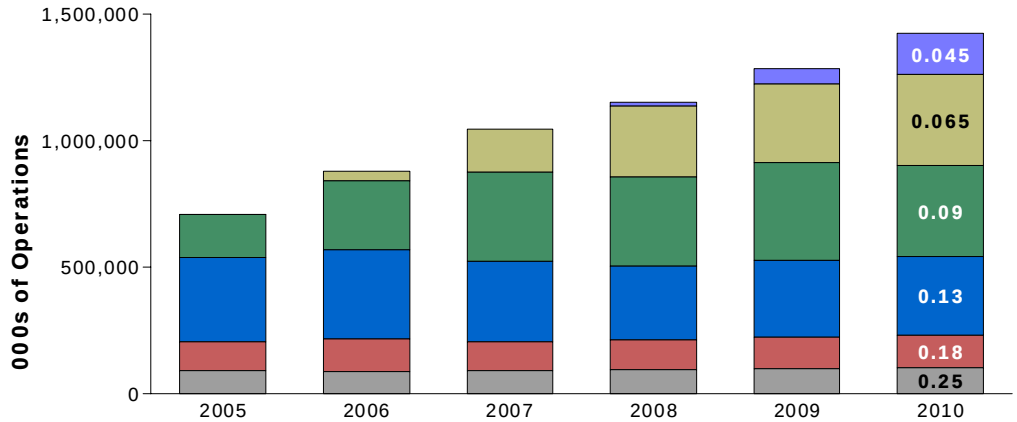
Slurry and Pad market growing at a CAGR of 14% (2006 to 2010).

- **2006 $1.2 Billion**
- **2010 $2.1 Billion**



2005 LEADING SUPPLIERS ALL CONSUMABLES (%)





COLLABORATION IN CMP

Pre-competitive Development

- Pad development with Customers, Universities and Consortia.
  - Getting hold of the right substrates is key.
- Suppliers were able to offer standard products, but customer needs are now evolving.
  - Pad designs generally set by early collaboration.
  - Partner choice is critical.
  - Microcustomization by joint development is now being requested as users understand the process interactions.

Early Commercialization / Growth

- Slurries are more often customized in fast turn optimization tests.

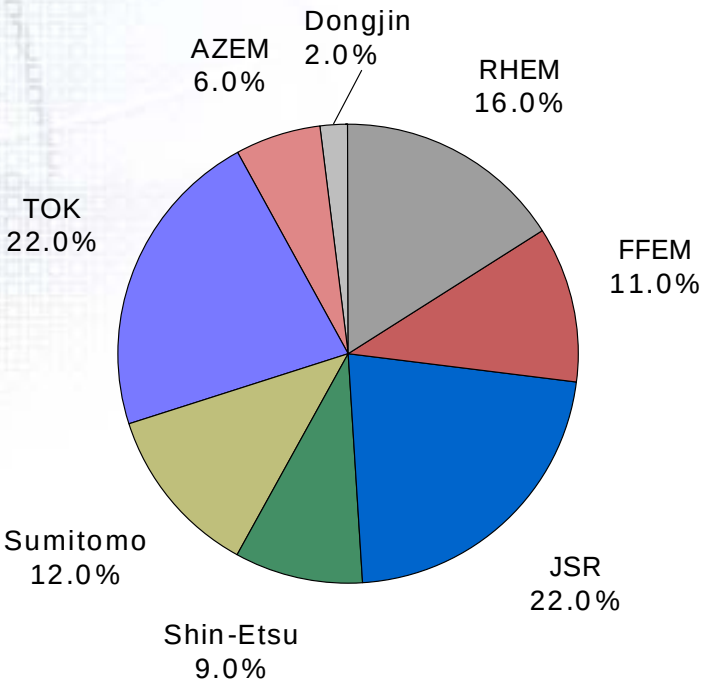
Comments

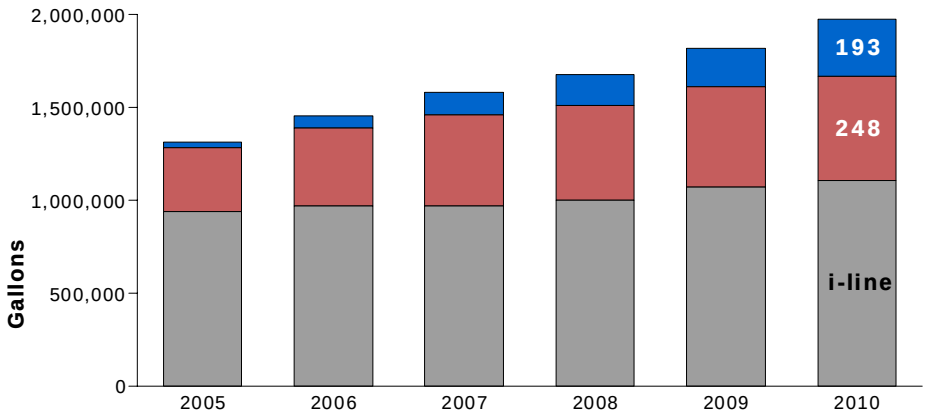
- Formalized collaboration with key customers uses about 40% of product development resources.

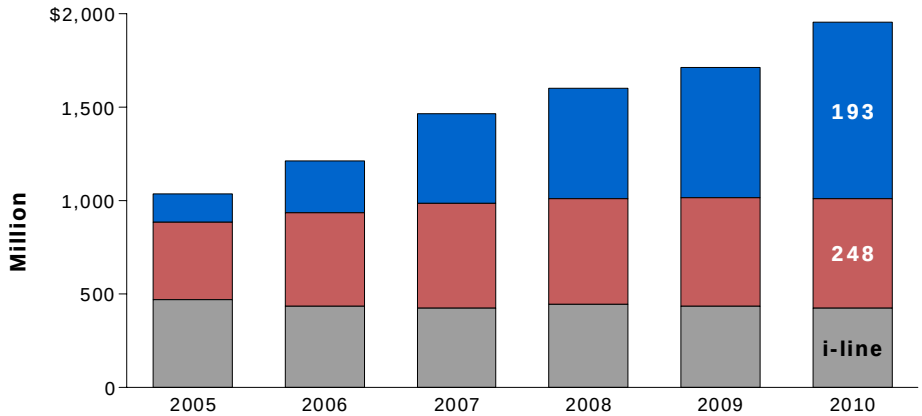
PHOTORESISTS MARKET OVERVIEW

Photoresist market growing at a CAGR of 13% (2006 to 2010).

- **2006 $1.2 Billion**
- **2010 $1.9 Billion**







COLLABORATION IN PHOTORESISTS

Pre-Competitive Development

- Significant collaboration with several consortia. Personnel commonly work on-site.
- Collaboration with equipment producers is uncommon.
- Novel materials are prescreened at key customers under formal agreements.
- R&D is driven hard to meet the requirements at key customers (1 - 6).

Early Commercialization / Growth

- Increasing demand for microcustomization. Leads to SKU growth and significant QA requirements.
- More ad hoc partnering.

Mature Products

- Few product consolidation collaborations.
- Back integration for yield optimization is limited by high switching costs.

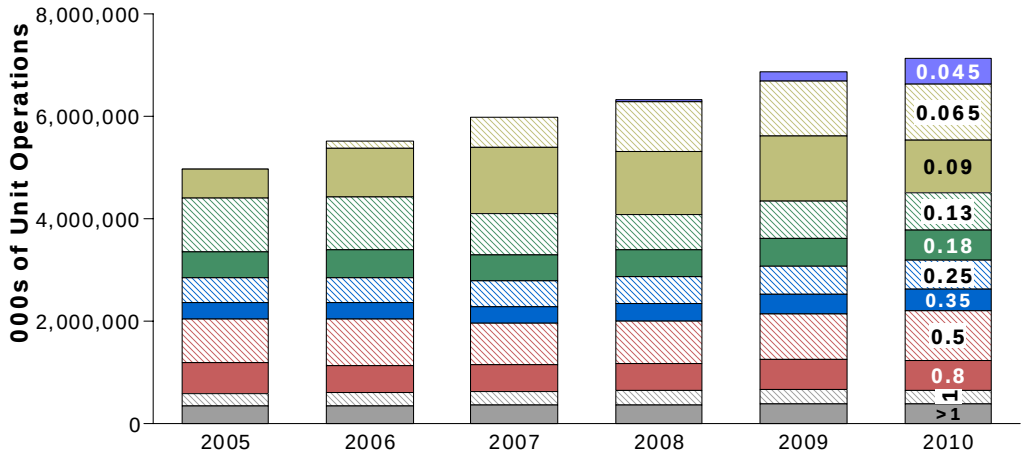
Comments

- More than 50% of resources are focused on collaboration activities.

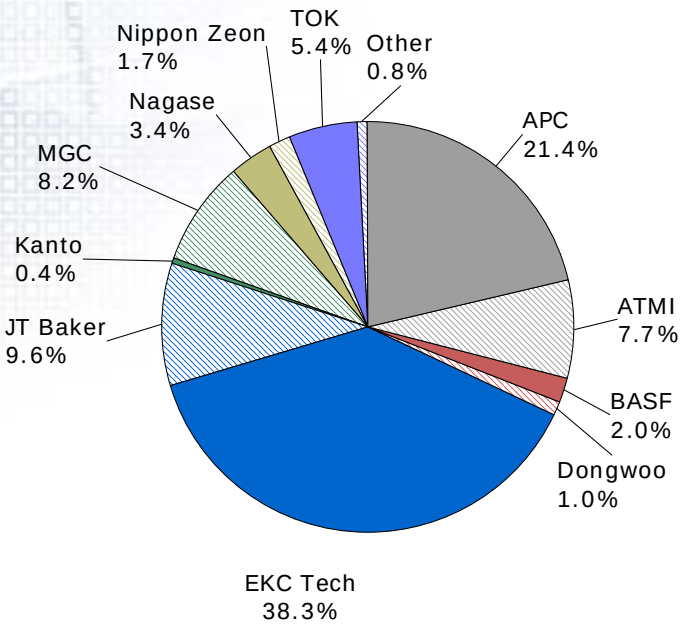
CLEANS MARKET OVERVIEW

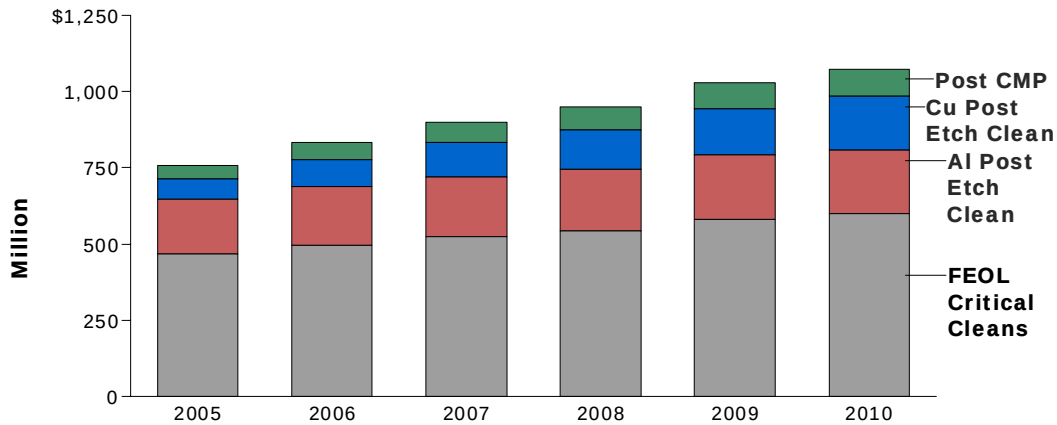
Cleans market growing at a CAGR of 7% (2006 to 2010).

- **2006 $833 Million**
- **2010 $1.1 Billion**



2005 ADVANCED CLEANS AND POST CMP CLEANS





Linx Report WAFER CLEANING AND SURFACE PREPARATION; TECHNOLOGIES AND MARKETS

COLLABORATION IN CLEANING

Pre-Competitive Development

- Cleans are at the whip end of integration development. It is critical to get the right substrates and solve issues.
- Few projects survive without customer pull.
- Equipment developments have driven increasing collaboration with single wafer tool manufacturers.

Early Commercialization / Growth

- Customer driven, ad hoc collaboration is most common.

Comments

- 95% of resources dedicated to collaboration.
- Significant amounts of field support required.
- Upstream collaboration is key to define favorable specification and cost positions.

ANCILLARY CHEMICALS

Pre-Competitive Development

- Platform development is in-house after roadmapping efforts define directions.
- Product Development Protocol defines the need for early customer pull. This can be a customer of OEM, but end customer linkage is seen as critical.
- Formal agreements on IP are put in place early.

Early Commercialization

- Collaboration seen as necessary to test integration, develop material platform further, and conduct demos.

Mature Products

- Product rationalization opportunities are not ignored, but may not be pushed either.

Comments

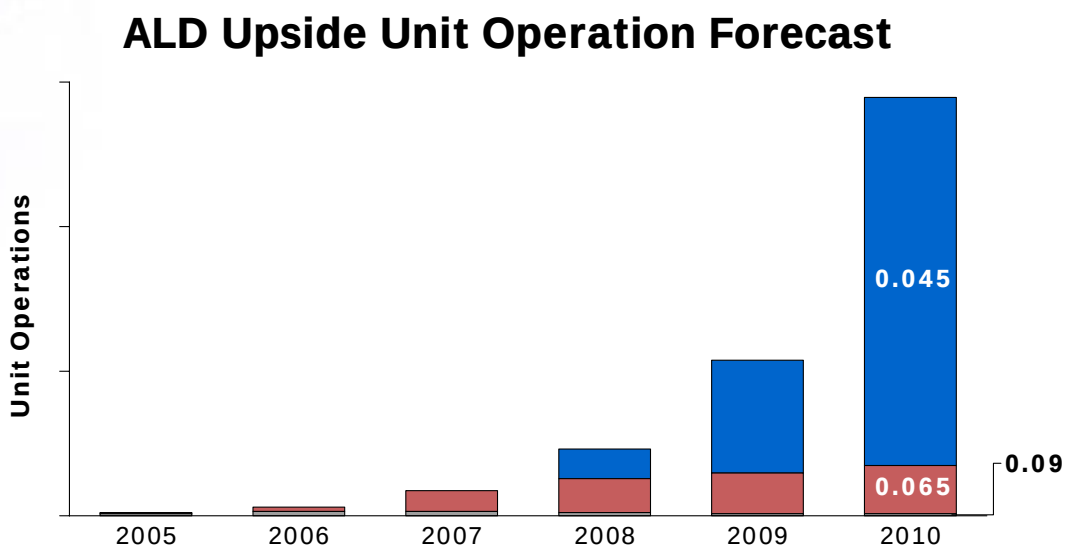
- Total resource allocation on collaboration about 66%

SEGMENT COMPARISON

	CMP	PHOTORESIST	CLEANS	ANCILLARY
% Of Revenues For Product Development	>11%	>12%	4%	>8%
% Of R&D Spend For Equipment Depreciation	n/a	30 to 40 %	Increasing	High
Proportion Of Collaborative Work In Pre-Competitive Development	40%	>50%	95%	0%
Proportion Of Collaborative Work In Commercialization	60%	>50%	95%	66%
Proportion Of Collaborative Work In Mature Products	Little	Little	Little	Little
IP Sharing	Competence	Competence		
Type Of Collaboration Agreements	Formalized	Formalized Ad hoc	Formalized PD Procedure	Formalized PD Procedure
Key Collaborators	Customer OEM Consortia Universities	Customer Consortia	Customer Consortia OEM Upstream Suppliers Universities	Customer OEM

THE ALD CHALLENGE

- Collaboration models are being challenged by ALD processes.
- Potential unit operations show explosive growth.
- Materials market potential is limited by materials usage and CoO concerns.
- Users want a “turn key process.”
- Significant integration requirements.



CONCLUSIONS

- Collaboration is used by successful materials suppliers to drive their businesses
  - The “crap circle” is not crap.
  - It remains an open question if more collaboration will bridge the R&D gap, or even if there is capacity for more collaboration.
- Partner choice is critical to meeting objectives of a collaborative program.
  - Both in execution and in achieving the desired result.
- Significant opportunity exists in major materials segments.
- Little collaboration is taking place to optimize costs or efficiency.
- Equipment makers and chipmakers should endeavor to be better collaboration partners to obtain early access to materials.