

STRATEGIC COST MODEL

A Collaborative Development between Linx Consulting and IC Knowledge

Background

Based on real world product process flows and device roadmaps, with modifications for the latest process developments, the Strategic Cost Model projects wafer production costs, taking into account direct materials, depreciation, and other wafer fab costs for a large number of existing fab locations and devices. The model provides a detailed cost estimate of wafer costs, equipment set characteristics, and key consumables for historic, current and future scenarios, and can be extensively customized to develop new hypothetical process and product simulations in various regions.

The model utilizes detailed manufacturing process flow look-up tables, and multiple patterning options to develop fab and wafer specific cost simulations. The process flows are extended to future product generations to give estimates of likely process and material requirements for novel devices. Flexible customization allows simulation of complex production scenarios including the use of EUV and other advanced process technologies.

The model was developed to provide detailed scenarios analysis capability. ***All process blocks, yields, and equipment definitions (cost, throughput, footprint, etc.) fab parameters and utilities as well as materials consumption parameters volumes, prices, types can be accessed and directly modified to develop various cost scenarios.***

1. Pre-Populated Fab Options & Device Categories

Device Producers	Device Categories
<ul style="list-style-type: none">• Global Foundries• Intel• Micron• SK Hynix• Samsung• TSMC	<ul style="list-style-type: none">• Foundry – ASIC• DRAM• 2D NAND• 3D NAND• MPU

2. Wafer Cost Outputs

	Process			Masks
Current	20nm - TSMC - SOC			70
	\$M/yr	\$/waf	\$/cm ²	\$/mask
Starting wafer	\$86.40	\$100.00	\$0.141	NA
Direct labor	\$52.66	\$60.95	\$0.086	\$0.871
Depreciation	\$2,030.14	\$2,349.70	\$3.324	\$33.567
Equipment maintenance	\$573.58	\$663.86	\$0.939	\$9.484
Indirect labor	\$97.48	\$112.82	\$0.160	\$1.612
Facilities	\$167.91	\$194.34	\$0.275	\$2.776
Consumables	\$364.52	\$421.90	\$0.597	\$6.027
Total unyielded wafer cost	\$3,372.69	\$3,903.58	\$5.522	\$54.337
Wafer yield	NA	96.6%	NA	NA
Yielded wafer cost	\$3,492.85	\$4,042.66	\$5.719	\$56.273

Starting wafer type	Epi
Mask set amortization	No

Fab	TSMC - Fab 14-P6	
Investment Category	\$M	\$M/1K wpw
Equipment	\$8,193.99	\$443.8
Equipment installation	\$806.16	\$43.7
Automation	\$817.60	\$44.3
Building	\$221.96	\$12.0
Building systems	\$517.91	\$28.1
Total	\$10,557.62	\$571.9

3. Lithography Alternatives

The model provides the user the ability to modify and adjust next generation lithography alternatives and comes with almost 100 variations of multi-patterning schemes that can be modeled, including when EUV comes on-line.

4. Equipment Counts and Cost Outputs

Equipment counts	Initial
Exposure clusters (exposure tools with tracks)	71
Dry etching and ashing	564
Thermal (furnace and RTP)	82
Implant	116
Wet processing (cleans and etches)	332
Metrology and inspection	531
PVD and Plating	189
CVD and ALD	559
Spin-on	202
CMP	83

Note: This is a high-level output. Additional cost and equipment segmentation data is also provided

5. High Level Consumables Output

Consumables		
	Cost (\$M/yr.)	Cost (\$/waf.)
Reticles	\$0.0	\$0.00
Lithography Materials	\$142.7	\$132.13
Bulk gases	\$60.9	\$56.41
Quartz ware	\$6.1	\$5.63
Cleanroom and safety supplies	\$20.8	\$19.23
Wet chemicals	\$33.3	\$30.84
CMP slurry and pads	\$36.6	\$33.86
CVD precursors	\$32.2	\$29.81
ALD precursors	\$6.3	\$5.79
Etch gases	\$3.6	\$3.30
Implant sources	\$4.0	\$3.71
PVD Targets	\$17.7	\$16.40
Plating chemicals	\$3.7	\$3.40
Spin-on	\$0.0	\$0.00
Total	\$367.7	\$340.51

Note: This is a high-level output. Additional materials segmentation data is also provided

6. Detailed Consumables Outputs

Category	Materials Covered
ALD	Device spacers, DRAM capacitors, Flash 3D, Flash CT, HKMG, PCM
CMP	Slurries and pads for copper, barrier, DSL, HKMG, Oxide, Poly, STI, W
CVD	III-V Channel, capping oxide, Spacers, Ply plugs, DRAM caps, DRAM Gate, High-K Gate, ILD Low-K Logic Gate, ONO, Pad nitride, Passivation, PMD, STI, Strain, W, NF3, NH3, SiH4, WF6
Litho	By Wavelength – Rinses, BARCs, Developer, Hardmasks, Resist, Pre-Wet, SiBARC, SOC, TARC
Plating	Copper, Co, CoWP
PVD	Al, TaN, Ta, Cu, TaRu, IrO ₂ , PZT, HKMG, TiN, Ni, W, NiCr
Spin-on	Low-κ, PMD, STI
Cleans	SPM, APM, PERR, PCMP, etc.

Note: All materials can be adjusted for volume, price, dispense volumes, etc.

Completion

The model is updated multiple times per year and is sent to subscribers with revision notes.

Benefits

1. Runs in Excel
2. Updates on a regular basis
3. Assist in understanding future devices now
4. Scenario planning
5. Companywide or single user license

Fees

- The model is priced at \$14,000 for the first-year subscription. Subsequent years will be priced at \$10,000 for a license.
- Individual user subscriptions are priced at \$5,000.

Linx Consulting, Inc.

Company Mission:

To allow device manufacturers, chemicals and materials suppliers, equipment producers, the investment community, and other value chain participants to better participate in the global electronics industry through the provision of knowledge-based services. To offer differentiated value by providing technical, market, and enterprise consulting services that support and draw from multiple markets and applications, uniquely serving materials users, specifiers, and suppliers across multiple markets and market segments.

Focus:

Linx Consulting, Inc. offers electronic materials consulting services within the semiconductor, display, MEMS, energy, and nanotechnology segments. Drawing on many years of experience in development, marketing, and consulting, Linx Consulting, Inc. offers unparalleled expertise and capabilities for driving strategic and tactical data generation and decision making for users, specifiers, and suppliers of electronic materials.

How to Participate

This service is available via subscription only. To formally accept participation in this program, please sign this letter and return the signature page via fax (+1 973-210-3017) or scan to mthirsk@linx-consulting.com or mcorbett@linx-consulting.com.

Name/Email/Date:	
Company/Address	
Payment Options	Purchase Order #
	We can accept credit card orders. Please call +1 617-273-8837 for details.

Mike Corbett mcorbett@linx-consulting.com Office: +1 973 437 4517 Cell: +1 973 698 2331	Mark Thirsk mthirsk@linx-consulting.com Office: +1 617 273 8837 Cell: +1 774 245 0959
Andy Tuan atuan@linx-consulting.com Linx – Asia – Taipei Cell:+886 958 11222	Audrey Parton aparton@linx-consulting.com +1 570 595 6493

©Copyright Linx Consulting, Inc. 2018.

Linx Consulting, Inc. • www.linx-consulting.com •
T: 617.273.8837 • F: 973.210.3017 • PO Box 384, Mendon, MA 01756-0384