



# Summary of Environmental, Safety and Health Chapter ITRS 2007

ESH ITWG

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International Technology Roadmap for Semiconductors

2007 ITRS DRAFT DO NOT PUBLISH

San Francisco - July 18, 2007

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# OUTLINE

- Participants
- Key Themes for 2007
- Reorganized Tables
- Table Revisions
- Supplemental Tools



# Participants

- James Beasley – ISMI
- Hans Peter Bipp – Infineon
- David Harman – Intel
- Bob Helms – University of Texas
- Shigehito Ibuka – TEL
- Jim Jewett – Intel
- Joey Lu – TSIA
- Joseph K.C. Mau – Powerchip Semiconductor
- Phil Naughton – ISMI
- Takayuki Ohgoshi – NEC Electronics
- Tetsu Tomine – Seiko-Epson
- Walter Worth – Sematech
- Munetsugu Yamanaka - TEL



# ESH Key Themes for 2007

- Focus on critical chemistry/materials needs
- Improvement of energy efficiency



# Reorganized Tables

- Chemical/Materials Tables focus on chemical selection
- Process Tables focus on process and tool design
- Facilities Table (new) focus on support systems and fab level design



# Table Revisions

- Added “continuous improvement” approach
  - ID need to establish baseline from which improvement is measured
  - Retains node “step function” needs (e.g. – EUV)
- ERM included in tables
  - Three-step approach to ESH risk:
    1. Develop ESH Risk Assessment Methodology
    2. Assess Risk
    3. Develop Solutions for Risk
- New Equipment Design
- Incorporated waste and air emission metrics in Facilities Table



**Table 105a Chemicals and Materials Management Technology Requirements—Near-term Years (DRAFT REV. 4)**

\* The Environment, Safety, and Health new chemical screening tool (Chemical Restrictions Table) is linked online

Year of Production	2007	2008	2009	2010	2011	2012	2013	2014	2015	Driver
DRAM ½ Pitch (nm) (contacted)	65	57	50	45	40	36	32	28	25	
MPU/ASIC Metal 1 (M1) ½ Pitch (nm)(contacted)	68	59	52	45	40	36	32	28	25	
<b>Interconnect</b>										
Low- materials—spin-on and CVD	Establish chemical utilization and process byproducts baseline	Maintain or improve chemical utilization* by 10%	Maintain or improve chemical utilization* by 10%			Maintain or improve chemicals utilization* by 10%				
Copper deposition processes (conventional and alternative)	75% copper reclaimed/recycled	85% copper reclaimed/recycled	99% copper reclaimed/recycled							
CVD chamber clean (plasma)	Alternatives with improved ESH impacts (e.g. lower GWP, improved utilization); characterize process byproducts.	Alternatives with improved ESH impacts. Maintain or improve chemical utilization by 10%; minimize process	Alternatives with improved ESH impacts. Low ESH impact chemistries. Maintain or improve chemical utilization by 10%; minimize process byproducts.			Alternatives with improved ESH impacts. Low ESH impact chemistries. Maintain or improve chemical utilization by 10%; minimize process byproducts.			Global Warming	
	Reduce Global Warming Impact (lower GWP emissions; improved utilization) without increasing ESH risk		Reduce Global Warming Impact (lower GWP emissions; improved utilization) without increasing ESH risk			Reduce Global Warming Impact (lower GWP emissions; improved utilization) without increasing ESH risk				
3-D deep silicon etching	Characterize emissions; establish baseline.	Reduce Global Warming Impact (lower GWP emissions; improved utilization) without increasing ESH risk. Maintain or improve chemical utilization by 10%.	Reduce Global Warming Impact (lower GWP emissions; improved utilization) without increasing ESH risk. Maintain or improve chemical utilization by 10%.			Reduce Global Warming Impact (lower GWP emissions; improved utilization) without increasing ESH risk. Maintain or improve chemical utilization by 10%.			Global Warming	
<b>Emerging Research Materials</b>										
Nanomaterials	Establish ESH risk assessment technique. Conduct ESH risk assessment of materials.			Conduct ESH risk assessment of materials.						
Biological materials and their waste	Establish ESH risk assessment technique. Conduct ESH risk assessment of materials.			Conduct ESH risk assessment of materials.						
Materials for novel logic and memory	Conduct ESH risk assessment of materials.			Conduct ESH risk assessment of materials.						



**Table 106a Process and Equipment Technology Requirements (DRAFT REV. 4)**

\* The Environment, Safety, and Health new chemical screening tool (Chemical Restrictions Table) is linked online

Year of Production	2007	2008	2009	2010	2011	2012	2013	2014	2015	Driver
DRAM ½ Pitch (nm) (contacted)	65	57	50	45	40	36	32	28	25	
MPU/ASIC Metal 1 (M1) ½ Pitch (nm)(contacted)	68	59	52	45	40	36	32	28	25	
<b>Interconnect</b>										
Low- processing spin-on and CVD	Establish chemical utilization and process byproducts baseline	Maintain or improve chemical utilization* by 10% ; characterize process emissions and byproducts					Maintain or improve chemicals utilization* by 10% ; characterize process emissions and byproducts			
Copper deposition processes (conventional and alternative)	Baseline copper processes; optimize processes to minimize consumables and waste	Optimize copper processes to reduce consumables and waste by 25%								
CVD chamber clean (plasma)	Optimize processes to minimize ESH impact; maximize utilization; minimize GWP emissions. Characterize emissions and byproducts.									
3-D deep silicon etching	Characterize emissions; establish baseline	Reduce Global Warming impact (lower GWP emissions; improved	Reduce Global Warming impact (lower GWP emissions; improved utilization) without increasing ESH risk. Maintain or improve	Reduce Global Warming impact (lower GWP emissions; improved utilization) without increasing ESH risk. Maintain or improve						
<b>Emerging Research Materials</b>										
Nanomaterials	Establish ESH risk assessment technique. Conduct ESH risk assessment of materials, processes and equipment	Conduct ESH risk assessment of materials, processes and equipment								
Biological materials and their waste	Establish ESH risk assessment technique. Conduct ESH risk assessment of materials, processes and equipment	Conduct ESH risk assessment of materials, processes and equipment								
Materials for novel logic and memory	Conduct ESH risk assessment of materials, processes and equipment	Conduct ESH risk assessment of materials, processes and equipment								
<b>New Equipment</b>										
Eco-design	Develop eco-design criteria, establishing metrics and targets for minimized environmental footprint and impact. Design process and ancillary equipment to minimize environmental footprint, and safety and health impact									
Design for Maintenance	Design equipment so that commonly serviced components and consumable items are easily and safely accessed									
Energy Consumption (kwh per cm2) [1]	Characterize energy requirements for process and ancillary equipment. Optimize energy consumption. Add idle capability to ancillary equipment (pumps, etc.); reduce energy requirements by 15% per technology node									
Water and other utilities (liters or m3 / cm2) [1]	Characterize water and utilities requirements for process. Optimize consumption. Determine feasibility for water recycle/reclaim; reduce water and utilities requirements 15% per technology node									
Chemicals (gms/cm2) [1]	Conduct ESH risk assessment of processes and equipment. Maintain or improve chemical utilization; characterize process emissions and byproducts; reduce chemical consumption 15% per technology node									



# Chemical Restrictions Screen

Issues & Characterization	Show Stopper	High Restriction Potential	Medium Restriction Potential
<p><b>List of Chemicals or Raw Materials Subject to Actual or Potential Manufacture or Use Restrictions</b></p>	<p>Asbestos Materials            Certain glycol ethers            Polychlorinated biphenyls            Fully halogenated chlorofluorocarbons (CFCs)            Carbon tetrachloride            1,1,1 trichloroethane            Halons 1211, 1301, 2402            Hydrobromofluorocarbons (HBFCs)            HCFC 141b  <b>Polybrominated biphenyls (PBBs) and their ethers/oxides (PBDEs)</b>  <b>Cadmium compounds</b>  <b>Lead compounds</b>  <b>Mercury compounds</b>  <b>Hexavalent Chromium compounds</b>  <b>Polychlorinated Biphenyls (PCB)/ Terphenyls (PCT)</b>  <b>Polychlorinated Naphthalene (PCN)</b>  <b>Short Chain Chlorinated Paraffins (C10-13, Cl &gt;50%)</b>  <b>Tributyl tin (TBT) and, Triphenyl tin (TPT) compounds</b>  <b>Certain Azo Colorants</b></p>	<p>Hydrochlorofluorocarbons (HCFCs)            Perfluorooctyl sulfonates (PFOS)  <b>Cadmium compounds</b>  <b>Lead compounds</b>  <b>Mercury compounds</b>  <b>Hexavalent Chromium compounds</b></p>	<p>Perfluorocompounds (PFCs)            - SF6                      - C4F10            - C2F6                     - C5F12            - CF4                        - C6F14            - NF3            - C4F8            - CHF3            - C3F8            Hydrofluorocarbons (HFCs)            Perfluorooctanoic acid (PFOA) and its salts            Certain phthalates            Phenols            Perfluoroalkyl sulfonates (PFAS)            Ethylene Oxide            Ethylene Chloride</p>

