Environmental, Safety and Health Chapter ITRS 2009

ESH ITWG

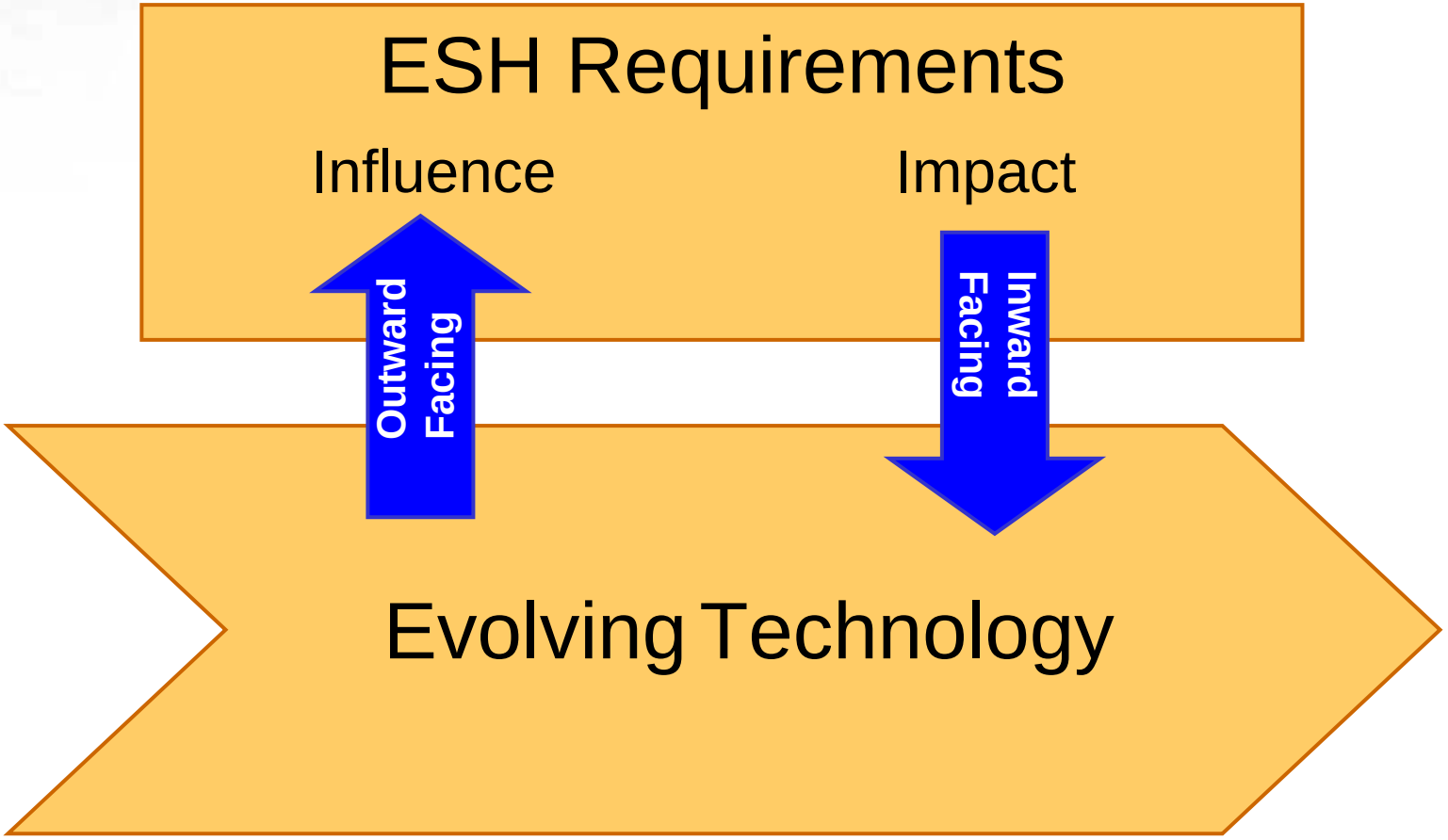
Jim Jewett

Hans-Peter Bipp – Infineon
Jim Jewett – Intel
Joey Lu - ITRI
Mike Mocella – DuPont
Takayuki Ohgoshi – NEC Electronics
Advisors:
Andreas Neuber – Applied Materials
James Beasley – ISMI
Minoru Kagino – Toshiba
Shigehito Ibuka - TEL

AGENDA

- Characterization Scheme
  - Segmentation of ESH “Intrinsic” requirements into Domains
- Update of Restrictions Table for Chemicals
- 450mm Preliminary Evaluation
- Comprehending Impact of Climate Change Requirements (Energy/PFCs) in Resource Conservation area

Harmonizing ESH Policy and Technology Requirements



•Missing the ESH ITRS requirements would not typically result in the technology not performing – but it may inhibit the technology from being implemented due to regulatory or economic factors

ESH Characterization

ESH Category Details

Critical: essential item for technology success/implementation as well as ESH benefits; failure to address could compromise the ability to insert the technology into manufacturing; normally related to a potential or existing regulatory issue, whether internally or externally based, and in at least one of the ITRS member regions (HIGHEST PRIORITY)

Important: key item for process success as well as ESH benefits; failure to address could compromise the CoO of the technology in manufacturing; normally related to factors such as throughput, yield, material and/or tool costs (including disposal/abatement), and the like (MEDIUM PRIORITY)

Useful: key item for ESH benefits, but without any clear additional factors which would place it in either of the above two categories; failure to address could compromise the ability to achieve the lowest ESH impact for the technology when inserted into manufacturing (LOWER PRIORITY)

Table ESH3a Chemicals and Materials Management Technology Requirements—Near-term Years

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*
Interconnect									
Low-κ materials—spin-on and CVD **Important**	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) **Important**	75% copper reclaimed/recycled	85% copper reclaimed/recycled			99% copper reclaimed/recycled				
Advanced metallization including barrier and nucleation deposition **Useful**	Establish chemical utilization* and process byproducts baseline	Maintain or improve chemical utilization* by 10%; minimize process byproducts		Maintain or improve-chemical utilization* by 10%; minimize process byproducts			Maintain or improve chemicals utilization* by 10%; minimize process byproducts		
Planarization methods **Important**	Characterize emissions and consumables; establish baseline.	> 15% Reduction in consumables from baseline					2% reduction in consumables per year		
Plasma etch **Critical (3a-1)**	Alternatives with improved ESH impacts. Maintain or improve chemical utilization*; characterize process byproducts.	Alternatives with improved ESH impacts. 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.			Alternatives with improved ESH impacts. Low ESH impact chemistries. Maintain or improve chemical utilization* by 10%; minimize process byproducts.		
CVD chamber clean (plasma) **Critical (3a-2)**	Alternatives with improved ESH impacts (e.g. lower GWP, improve utilization); characterize process byproducts.	Alternatives with improved ESH impacts. 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.			Alternatives with improved ESH impacts. Low ESH impact chemistries. Maintain or improve chemical utilization* by 10%; minimize process byproducts.		

Chemical Restrictions Tool

List of chemicals subject to actual or potential restrictions on manufacturing applications or product content restrictions

Show Stopper	High Restriction Potential	Medium Restriction Potential
Process Materials Restrictions (Restrictions on use of process materials utilized in Intel manufacturing processes).		
Asbestos Materials Polychlorinated biphenyls (PBBs) Fully halogenated chlorofluorocarbons (CFCs) Carbon tetrachloride 1,1,1, Trichloroethane Halons 1211, 1301, 2402 Hydrobromofluorocarbons (HBFCs) HCFC 141b	Hydrochlorofluorocarbons (HCFCs) Perfluorooctyl Sulfonates (PFOS) Chlorinated organic compounds Brominated organic compounds Certain glycol ethers Sulfur hexafluoride (SF6) Hexabromocyclododecane (HBCDD) Bis (2-ethyl(hexyl)phthalate) (DEHP) Cobalt Dichloride Butyl benzyl phthalate (BBP) Dibutyl pthalate (DBP) Cadmium compounds Lead compounds Mercury compounds Hexavalent chromium compounds Beryllium Nonylphenol Nonylphenol Ethoxylate	Perfluorocompounds (CHF3, CF4, C2F6, C3F8, C4F8, C4F10 C5F12, C6F14) Nitrogen trifluoride (NF3) Hydrofluorocarbons Perfluorooctanoic acid (PFOA) and its salts Certain phthalates Phenols Perfluoroalkylsulfonates (PFAS) Ethylene oxide Ethylene dichloride Polyaromatic hydrocarbons Arsenic Gallium Arsenide Arsine
Product Content Restrictions (Restrictions on chemical contents of semiconductor commercial products)		
Asbestos Materials Polychlorinated biphenyls (PCB) Fully halogenated chlorofluorocarbons (CFCs) Carbon tetrachloride 1,1,1, Trichloroethane Halons 1211, 1301, 2402 Hydrobromofluorocarbons (HBFCs) HCFC 141b Polybrominated biphenyls (PBBs) Polybrominated biphenyl ethers/oxides (PBDEs) Polychlorinated tetraphenyls (PCT) Polychlorinated naphthalene (PCN) Short chain chlorinated paraffins (C10-13, Cl >50%) Cadmium compounds Hexavalent chromium compounds Lead compounds Mercury compounds Tributyl tin (TBT) and Triphenyl tin (TPT) compounds Certain Azo colorants	Hydrochlorofluorocarbons (HCFCs) Perfluorooctyl Sulfonates (PFOS) Chlorinated organic compounds Brominated organic compounds Certain glycol ethers Sulfur Hexafluoride (SF6) Hexabromocyclododecane (HBCDD) Bis (2-ethyl(hexyl)phthalate) (DEHP) Cobalt Dichloride Butyl benzyl phthalate (BBP) Dibutyl pthalate (DBP)	Perfluorocompounds (CHF3, CF4, C2F6, C3F8, C4F8, C4F10 C5F12, C6F14) Nitrogen trifluoride (NF3) Hydrofluorocarbons Perfluorooctanoic acid (PFOA) and its salts Certain phthalates Phenols Perfluoroalkylsulfonates (PFAS) Ethylene oxide Ethylene dichloride Polyaromatic hydrocarbons Arsenic Gallium Arsenide Arsine Antimony trioxide Beryllium Polyvinyl chloride (PVC) Other brominated flame retardants

Work in Progress: Not for Distribution

450mm

- Preliminary ESH program evaluation, 450mm does not directly impact the ITRS ESH technology requirements
  - 450mm (current program for energy, water and emissions) will take advantage of existing solutions (implementation vs. invention)
  - 450mm will be able to incorporate results of current 300mm work (e.g. – idle mode, chemical utilization)
  - Contingent upon better understanding of 450mm technology as we get closer

2008 Energy Conservation Changes

	Year of Production	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Table 103a&b ESH Difficult Challenges																	
Table 104 ESH Intrinsic Requirements																	
II.. Process and Equipment Technology Requirements																	
	*Energy Consumption **(electricity)***																
was	Total fab tools (kWh/cm^2) [2]	0.40–0.35			0.35-0.30			0.30-0.25			0.25						
is	**Total fab tools (kWh/cm2) [2][3]**	0.5			0.43			0.35			0.30-0.25						
is	~~Tool energy usage (% of 2005 baseline)~~	~~90~~			~~80~~			~~Functional Area Goals TBD~~			~~Functional Area Goals TBD~~						
is	~~Tool total equivalent energy* (% of 2007 baseline)~~	~~100~~		~~80~~	~~70~~			~~60~~			~~50~~						
III.. Facilities Technology Requirements																	
	Energy Consumption																
was	Total fab energy usage (kWh/cm2)	1.5-1.3			1.3-1.1			1.1-1.0			1.0-0.75						
is	**Total fab energy usage (kWh/cm2) [3**	1.0			0.85			0.7			0.6-0.5						
was	Total fab support systems energy usage (kWh/cm^2) [2]	0.8–0.6			0.6–0.5			0.5-0.4			0.4-0.25						
is	**Total fab support systems energy usage (kWh/cm2) [2]**	0.5			0.43			0.35			0.30-0.25						
is	~~Reduce total fab energy usage (% of 2007 baseline)~~	~~100~~		~~90~~	~~80~~			~~70~~			~~50~~						
Table 105 Chemicals and Materials Management Technology Requirements																	
Table 106 Process and Equipment Technology Requirements																	
Table 107 Facilities Technology Requirements (ALL NUMERICAL VALUES IN TABLE MIGHT CHANGE)																	
	Energy (electricity, natural gas, etc.)																
was	Total fab* energy consumption (kwh per cm2) [1]	1.9			1.6			1.35			1.2			1.1			
is	**Total fab tools* energy consumption (% of 2007 baseline)**	100			85			70			60			50			
is	~~Total site energy consumption reduction~~	~~Establish baseline~~	~~Reduce total comsumption 10% from baseline levels~~		~~Reduce total comsumption additional 10%~~			~~Reduce total comsumption additional 10%~~			~~Reduce total consumption by additional 5%~~			~~Reduce total consumption by additional 5%~~			
is	~~Cleanroom thermal management~~	~~Establish baseline~~			~~Reduce heat rejection from process and ancillary equipment to cleanroom air by 15% from baseline~~			~~Reduce heat rejection from process and ancillary equipment to cleanroom air by additional 15%~~			~~Reduce heat rejection from process and ancillary equipment to cleanroom air by additional 15%~~			~~Reduce heat rejection from process and ancillary equipment to cleanroom air by additional 15%~~			

Work in Progress: Not for Distribution

2008 Water Conservation Changes

		Year of Production	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Table 103a&b ESH Difficult Challenges																		
Table 104 ESH Intrinsic Requirements																		
	II.. Process and Equipment Technology Requirements																	
		Water Consumption																
		Surface preparation UPW use (% of 2005 baseline)	90			80			75			50						
		Tool UPW usage (% of 2005 baseline)	90			80			75			50						
	III.. Facilities Technology Requirements																	
		Water Consumption																
	is	~~Net feed water use (liters/cm^2) [2]~~	~~15~~		~~15-12~~		~~12-10~~		~~10-8~~			~~8-6~~						
	is	~~Fab UPW use (liters/cm^2) [2]~~	~~8~~		~~8-7~~		~~7-6~~		~~6-4~~			~~4-3~~						
Table 105 Chemicals and Materials Management Technology Requirements																		
Table 106 Process and Equipment Technology Requirements																		
Table 107 Facilities Technology Requirements (ALL NUMERICAL VALUES IN TABLE MIGHT CHANGE)																		
		Water																
	was	Total fab* water consumption (liters/cm2) [1]	14			12.5			11			10			9			
	is	Total fab* water consumption (liters/cm2) [1]	6.5			5.4			4.4			3.6			3.0			
	is	~~Total site water consumption reduction~~	~~Establish baseline~~		~~Reduce total comsumption 10% from baseline levels~~	~~Reduce total comsumption additional 10%~~			~~Reduce total comsumption additional 10%~~			~~Reduce total consumption by additional 10%~~			~~Reduce total consumption by additional 10%~~			
	was	Total UPW consumption (liters/cm2) [1]	8			7			6			5			4.5			
	was	UPW recycled/reclaimed** (% of use)	70			75			80			85			90			
	is	UPW recycled/reclaimed** (% of use)	70			75			80			85			90			

Work in Progress: Not for Distribution

2010 Issues Forward

How to Harmonize ESH Categorization with Technology Requirements

- Refine Prioritization

Energy and Carbon Footprint

- Improve perspective for new technology role in energy conservation

Timely availability of Chemical Assessment Data and Methodologies

- Historical problem but increasing in intensity

450mm

- More in depth evaluation of 450mm impacts (new technology perspective)

Evaluate how ESH requirements may differ between Memory and Logic R/Ms