2019 Edition

Chapter 18: Supply Chain

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Chapter 18: Supply Chain

This chapter is in preparation, and will be integrated into the Roadmap at Version 1.1, planned for the end of 2019. In its place is the following summary and a series of slides giving the current status of integrated photonics and some information that is relevant to the progress needed over the next 10 to 15 years.

Executive Summary

Past technical roadmaps have not addressed supply chain dynamics, as there has not been a need to do so due to a fairly linear ecosystem. However, electronics have shifted away from the monolithic systems that were prevalent in the IT-dominated space, and toward a consumer-focused realm where communications and computing have become pervasive. Inevitably, supply chain dynamics have become far more complex.

With the industry now looking through the applications lens more so than ever, the packaging landscape has undoubtedly been impacted as well. There are several supply chain considerations that come into view as more packaging options become available for various applications. From supply chain trends (e.g., convergence, mergers and acquisitions) to challenges (such as material and equipment capability) to disruptions (e.g., geo-political, natural and human resources, regulatory, environmental health and safety), these factors must be taken into consideration when making technical and business decisions.

Heterogeneous Integration Roadmap

Chapter 18: Supply Chain

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Outline and Work in Progress

- Background and Objectives
- Scope
  - Confined to supply chain dynamics and challenges within heterogeneous integration
- Supply Chain Dynamics
  - Map supply chains by package type and application
- Challenges
  - Supply chain disruptions and considerations both current and future
- Future Chapter Development
  - Connect with supply chain needs and challenges in other HIR working groups

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Background & Objectives

- Past technical roadmaps have not addressed supply chain dynamics
- Electronics have shifted from monolithic systems to sense/compute where supply chain dynamics are more complex
- Key Factors
  - Product/application complexity
  - Geographical and political diversity
  - Supply chain disruptions
  - Supply chain development
- The focus of this working group will be on awareness as well as guidance on checkpoints for the industry when they are considering specific technical paths.

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Scope

- The scope of this group will encompass the full supply chain pertaining to heterogeneous integration (design and manufacturing) with specific focus given to the following:
  1. Supply chain disruptions and considerations:
     - Geo-political ramifications
     - Force majeure
     - EHS and regulatory activities
  2. Supply chain mappings (within scope) and trends:
     - Convergence (e.g. front-end equipment now in back-end, PCBA/SMT/EMS starting advanced packaging operations, etc.)
     - M&A, partnerships, and consolidation
     - Potential for vertical, horizontal integration (e.g., fabless acquiring fab capabilities)
     - Market entrants and exits

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Challenges

- Supply-chain Constraints
  - Natural & Human Resources
    - Example: Lack of talent availability due to misperceptions around microelectronics
  - Geo-political
    - Examples: U.S.-China Trade War; Japan-Korea Trade War (materials)
  - Regulatory and EHS
    - Example: Waste management issues
  - Continuity/Resilience
    - Examples: Dual+ sourcing, proximity
  - Force majeure
    - Example: Earthquakes, flooding

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Challenges *(continued)*

- Supply-chain Development
  - Equipment Capabilities
  - Materials Design

- Environmental
  - Transactional/Business Models
  - Innovation Pipeline

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Example -"Metal Deposition for Fan-Out Packaging"

- TSV cost forcing shift from one packaging architecture to another
- Emergence of mm-Wave driving need for low loss materials
  - Materials need to be low temperature tolerant, better stress control from compressive to tensile
  - PVD systems also need the flexibility to process such materials while maintaining productivity
- The mold and organic dielectrics absorb moisture which must be removed before any plasma processing, otherwise deposited metal will be contaminated
- New chamber designs needed to prevent particle generation (of carbon being a by-product of etch process)
- Chamber temperature control to prevent wafer warpage
  - Other considerations for handling increased warpages:
    - Vertical clearances in wafer cassettes, robot arm velocities to minimize rapid temperature transitions, optics calibration for wafer handling
  - Bond surface contamination of new materials used in FO-WLP negatively affects contact resist leading to reduced battery life (mobile applications). Preclean technology is used to mitigate contaminating gases

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Example -"Metal Deposition for Fan-Out Packaging"

Challenges	FO-WLP PVD Supply Chain
• TSV cost forcing shift from one packaging architecture to another	Trends/Forces
• Emergence of mm-Wave driving need for low loss materials:	Trends/Forces
➢ Materials need to be low temperature tolerant, better stress control from compressive to tensile	Development – Material Design
➢ PVD systems also need the flexibility to process such materials while maintaining productivity	Development – Equipment Capability
• Mold and organic dielectrics absorb moisture which must be removed before any plasma processing, otherwise deposited metal will be contaminated	Development – Material Design
• New chamber designs to prevent particle generation (of carbon being a by-product of etch process)	Development – Equipment Capability
• Chamber temperature control to prevent wafer warpage:	Trends/Forces
➢ Other considerations for handling increased warpages – Vertical clearances in wafer cassettes, robot arm velocities to minimize rapid temperature transitions, optics calibration for wafer handling	Development – Equipment Capability
➢ Bond surface contamination of new materials used in FO-WLP negatively affects contact resist leading to reduced battery life (mobile applications). Preclean technology is used to mitigate contaminating gases	Development – Material Design

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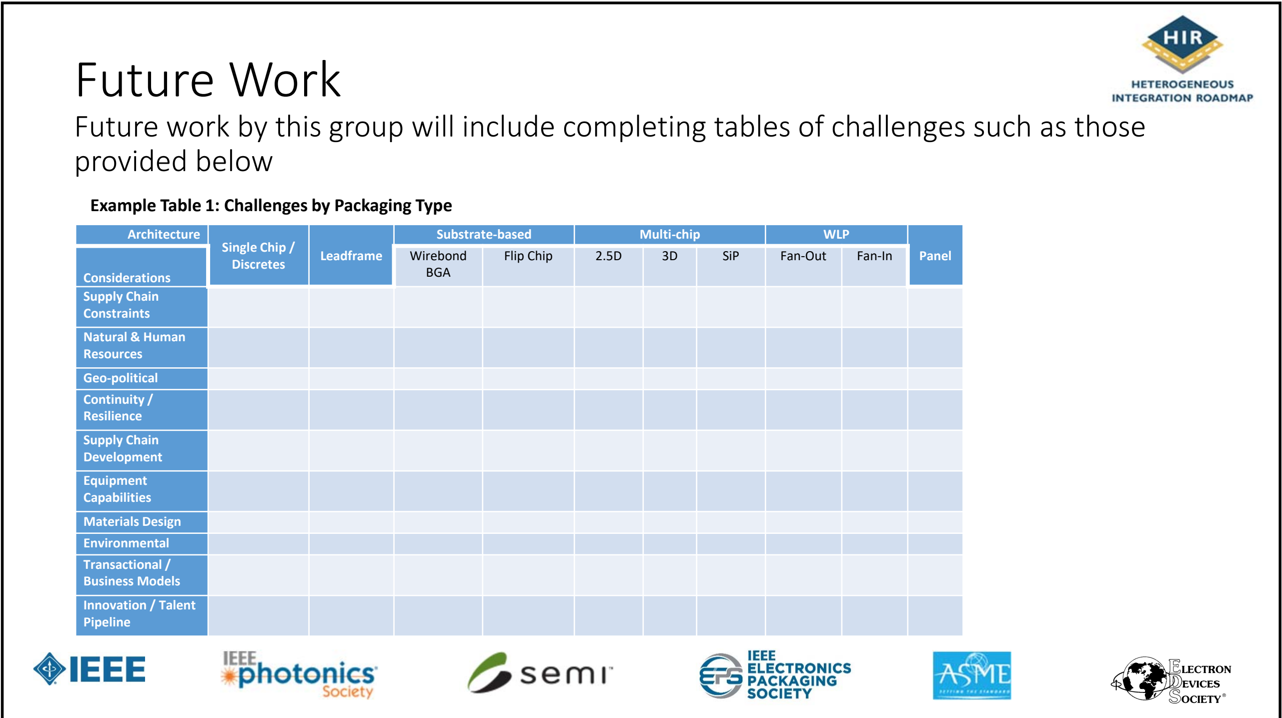

Future Work

Future work by this group will include completing tables of challenges such as those provided below

Example Table 1: Challenges by Packaging Type

Architecture / Considerations	Single Chip / Discretes	Leadframe	Substrate-based		Multi-chip			WLP		Panel
			Wirebond BGA	Flip Chip	2.5D	3D	SiP	Fan-Out	Fan-In	
Supply Chain Constraints										
Natural & Human Resources										
Geo-political										
Continuity / Resilience										
Supply Chain Development										
Equipment Capabilities										
Materials Design										
Environmental										
Transactional / Business Models										
Innovation / Talent Pipeline										

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Future Work *(continued)*

HIR HETEROGENEOUS INTEGRATION ROADMAP

Example Table 2: Challenges by Application

Architecture / Considerations	Automotive			High-Performance Computing		Photonics Integration	Medical	Other
	2.5D			Quantum	Neuromorphic			
Supply Chain Constraints								
Natural & Human Resources								
Geo-political								
Continuity / Resilience								
Supply Chain Development								
Equipment Capabilities								
Materials Design								
Environmental								
Transactional / Business Models								
Innovation / Talent Pipeline								

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