Roadmapping Advanced Packaging for Electronics Manufacturing with iNEMI Workshop Report

Conference:

InterPACK 2022, October 25-27, 2022, Garden Grove, CA, USA

Attendees:

- 17 on the sign-in sheet with roughly 5 others in attendance
- Roughly a 50:50 split between industry and academic/government agency attendees

Agenda:

Opening:	Introduction to iNEMI *[Shekhar Chandrashekhar, CEO, iNEMI]*
Question 1:	What is a technology roadmap? *[All]*
Presentation:	Roadmapping for Advanced Packaging & Heterogenous Integration: iNEMI's Perspective *[Francis Mullany, Director of Roadmapping, iNEMI]*
Question 2:	What are the main application/market and technical drivers for packaging and heterogeneous integration over the next 5 to 10 years? *[All]*
Question 3:	Of the drivers identified above, which ones are the most critical? *[All]*
Question 4:	What are the trends or expected state in 5, 10 years for the top four drivers? *[All]*

Presentation:

Roadmapping for Advanced Packaging & Heterogenous Integration: iNEMI's Perspective

Brainstorming

Raw data is available on request to fmullany@inemi.org.

Question 1: What is a technology roadmap?

The answers here were very much in line with iNEMI's own definition of technology roadmapping, with one additional element being mentioned by some:

- iNEMI definition: "Technology roadmapping navigates the gap between today's technology capability & tomorrow's needs" – with a focus on drivers, technical needs, gaps, technology challenges and potential solutions.
- Two contributions suggested more than articulating potential solutions, but additionally to outline actions and plans for technology development and workforce education.

That concept of actionable plans is very much in line with NIST-funded roadmaps such as MAPT, MRHIEP and the iNEMI-led 5G/6G MAESTRO.

Question 2: What are the main application/market and technical drivers for packaging and heterogeneous integration over the next 5 to 10 years?

Participants were asked to list the main drivers, both from the perspective of user/application pull and from that of technology push. Applications were grouped into one of three domains:

- Mission critical applications, where there is a high emphasis on availability and reliability, often in harsh environments, e.g. drive train control in electric vehicles and autonomous driving.
- Business-critical applications, where failure implies potentially significant business/customer losses, e.g. data-centre server infrastructure.
- Consumer applications, where systems are mass produced and have lower reliability and/or environmental requirements, e.g. AR/VR equipment.

For each of the above, here is rough categorization of the responses from the workshop attendees:

Mission-critical application drivers

- Medical sensing/diagnostics. (This topic was also highlighted in the consumer sector, but here the focus is on devices for use in medical settings such as hospitals, emergency treatment or critical-illness care.)
- Autonomous driving. (It should be noted that electrification of the mechanical power trains was also mentioned.)
- Robotics.
- Aerospace. (This was across a range of applications including space travel and military. High temperature operation was highlighted.)
- Power grid.
- High-power machines/electronics.

Business-critical application drivers

- High-performance computing for AI/ML. (Frequently mentioned.)
- Web 3.0. (Also referenced in the consumer sector.)
- Digital twins. (First of many with a strong industrial manufacturing sector perspective.)
- Digital manufacturing.
- Supply chain management.
- Communications infrastructure.
- Manufacturing for reliability. (Added after a verbal "from-the-floor" comment.)

Consumer application drivers

- Wearable electronics. (As noted above, this is closely related to the medical device market, however in many everyday health and wellness applications the requirements are less stringent.)
- Patches.
- Biosensors.
- Textile-based electronics. (Presumably extending beyond the health and wellness market segment.)
- Cell-based communications. (Including handsets.)
- Game consoles.
- Web 3.0. (Also referenced in business-critical applications.)

Technology push drivers

Here, the focus is on where technology developments have significant impact on packaging and heterogenous integration, independent of market drivers:

- Fine-pitched biocompatibility.
- Photonics.
- Quantum computing.
- Additive manufacturing.
- Space systems.
- Board-free technologies.
- Sustainable electronics.

Question 3: Of the drivers identified above, which ones are the most critical?

The attendees were asked to select which the above drivers (exactly as summarized above) are the most critical for/impactful on the evolution of packaging technologies. Attendees were given a number of "voting" sticky notes and were given to freedom to distribute them as they saw fit – e.g. for example all on one driver or distributed across a number of drivers.

The raw results of the voting are given in datafile available on request from fmullany@inemi.org. The top selected drivers were as follows:

1. High-performance computing for AI/ML
2. Photonics
3. Autonomous driving
4. Wearable electronics

The top two are clearly driven by the technologies needed for high-performance computing, particularly in data centres.

The latter two are more probably reflect the diversification of the environments into which we are putting electronics. This is particularly true if one assumes a certain conflation of autonomous driving with vehicle drive-train electrification, with its associated harsh operational environment.

Question 4: What are the trends or expected state in 5, 10 years for the top four drivers?

We did not have enough time to address this question.