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IPC Position on the European Commission's proposal for a European Chips Act

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IPC commends the European Commission for its Chips Act proposal, and we welcome the opportunity to share our perspectives on strengthening the European semiconductor supply chain and the wider electronics manufacturing ecosystem.

The current chip shortage has underscored the uniquely important role of semiconductors in the electronics that power almost all technologies from medical and defence technologies to consumer goods and industrial systems. Public and private sector investment in Europe's semiconductor industry is necessary to address the current chip shortage and avert similar supply chain crises in the future, but Europe's regional and economic security is also dependent upon its ability to design and produce the most cutting-edge semiconductor chips. In the future and today, advanced packaging plays a central role in this context.

With this eye to the future, IPC's primary message to the European Commission as well as to the European Parliament and Council is that the Chips Act should provide robust support for advanced packaging given its increasingly important role in chip performance and supply chain resiliency. Support should extend to both IC substrate fabrication and final package assembly and test; every effort should be made to leverage such investments to deliver benefits across the electronics manufacturing value chain.

About IPC

IPC is a global industry association serving more than 400 European-headquartered electronics companies. The association supports electronics manufacturers to build electronics better through technical standards, workforce programs, research, and advocacy. The European electronics manufacturing ecosystem supports 1 530 000 jobs in the EU and drives more than 308 billion GDP. It spans all segments of electronics manufacturing, including designers, printed circuit board (PCB) manufacturers, contract and assembly companies, suppliers, and leading original equipment manufacturers (OEMs) in the aerospace, information and communications technology, defense, medical, automotive, and industrial sectors.

Advanced Packaging Driving Semiconductor Advancements

Since the 1960s, the global semiconductor industry has used Moore's Law as a key benchmark for measuring the pace of advancements in chip manufacturing. Moore's Law refers to the doubling of transistors in an integrated circuit every two years. It held true for more than half a century, but the days of keeping pace with Moore's law are over. Silicon advancements have slowed and the costs have increased. Instead, semiconductor designers

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are leveraging advanced packaging as a means to achieve greater functionality and economic efficiencies previously realized through silicon scaling.

Advanced packaging, then, is no longer an ancillary activity. It is central to semiconductor innovation, and yet, the Chips Act is far too muted in explaining the critically important role advanced packaging plays in semiconductor advancements and in committing real resources to build capabilities and capacities that better match those found in Asia. Companies headquartered in Asia, in fact, are global leaders across the entire semiconductor supply chain, with the top companies dominating market share in semiconductor fabrication (TSMC, Samsung); advanced IC-substrate fabrication (Unimicron, Ibiden, SEMCO, Nan Ya, Shinko); and OSAT assembly and test, (in which Taiwan is the leader with nine companies including ASE+SPIL and Powertech Technology). Europe lags behind Asia in capacity, but technical capability is a source of concern as well. Asian manufacturers also dominate the printed circuit board (PCB) and electronic manufacturing services (EMS/ODM) sectors, where outsourcing and off-shoring have been prevalent over the past 20 years. Asia's dominance in electronics arises from the region's breadth of manufacturing capabilities from chips through advanced packaging through PCB fabrication and final hardware / system assembly capability.

Advanced Packaging Overview

Semiconductor chips are fragile and must be protected from thermal and mechanical stresses during operation. To provide this protection, chips are "packaged" using several different materials, mainly plastics. Once packaged, chips become active logic devices that perform computing and/or memory functions (among other functions as well). Chips are just one of many different types of essential components within an electronic system.

Protecting chips remains critically important, but advancements in packaging are now being driven by "on package integration," more commonly referred to as heterogeneous integration. Heterogeneous integration is the assembly of multiple separately manufactured chiplets (logic, memory, analog, mixed signal) in a single package. A chiplet is a functional circuit block fabricated on a wafer, typically in a smaller size than what would be possible in a system on chip. The chiplet can be applied to a substrate in a 2D configuration or stacked one on top of the other in a 3D configuration within a package to produce greater functionality and greater processing speed.

Semiconductor advanced packaging principally comprises two industry segments:

- **Integrated Circuit Substrate Fabrication:** IC substrate manufacturers produce the base layers used in the packaging of integrated circuit chips. The substrate connects the chips with each other and with the printed circuit board (PCB), in addition to protecting, reinforcing, and supporting the IC chip.

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- **Final Package Assembly and Test (e.g., OSAT):** These companies assemble bare semiconductors onto IC substrates and into protective packaging. After packaging, they conduct final testing to ensure that the packaged semiconductors meet performance specifications. In addition, it is important to note that traditional packaging of semiconductors is meanwhile supplemented by Embedding Technologies, where the packaging takes place by integration (embedding) **into** Printed Circuit Boards.

Because 'chips do not float', a chip must be connected to electronic systems. The chip is bonded first to an IC substrate to facilitate electronic connection within the package, after which the resulting component is bonded to a larger printed circuit board (PCB) that acts as the skeleton and nervous system of every electronic system.
If the components are embedded into Printed Circuit boards the devices are laminated inside the PCB and the interconnections are made during the manufacturing process of the Embedded PCB.

In summary, the following technologies need to be included in a definition of advanced packaging which spans semiconductor technologies, IC-substrates, and final package assembly and test:

a) **Microelectronic Semiconductor Components** – including active logic components (compute, memory, analog, mixed signal). Generally silicon based semiconductors.
b) **Power Semiconductor Components** – powering many different electronic systems, but also play an important role in the conversion of energy (EV automotive, renewable energy sources like solar cells, wind and fuel cells)
c) **Embedded Technologies** – embedded passives, as well as die/bridge/component technologies should be encouraged to develop and expand IC-substrate capabilities and capacity.

European Advanced Packaging Assessment
Pursuing a singular focus on chip manufacturing but failing to strengthen advanced packaging capabilities would *lengthen* the semiconductor supply chain, as manufacturers will continue to send their chips outside the EU for final component packaging and assembly. To achieve its goals related to innovation and resiliency, the Act must bolster the region's capabilities and capacities in advanced packaging and embedded technologies.

Though the financial headwinds are fierce, the EU has real opportunities to grow the region's advanced packaging activity. In March, Intel announced a 4.5 billion euro plan to stand up a state of the art back-end manufacturing facility.[1] Intel is joined by other companies that also want to expand their capabilities but resources will be needed to ensure that EU packaging, assembly and test services are brought in line with the scale of chip production envisioned.

[1] See Intel press release: https://www.intel.com/content/www/us/en/newsroom/news/eu-news-2022-release.html#gs.1006nvy

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Likewise, the EU has reason to be optimistic about IC substrate fabrication in what would otherwise be a gloomy landscape. In very different but equally exciting ways, AT&S and Schweizer Electronic are leading innovation in substrates and embedded electronics from their facilities in Europe. Other companies historically dedicated to printed circuit board fabrication are exploring IC substrate and embedded technology fabrication. The technical capabilities are growing but EU capacity in IC substrate fabrication remains weak to non-existent. Virtually every chip fabricated in Europe is assembled elsewhere using IC substrates that are also fabricated outside of Europe. This is true for both microelectronic and power-electronic advanced packaging. Bolstering these two industry segments (IC-substrates and OSAT) is critical to safeguarding European economic and regional security, as well as EU leadership in technological innovation.

Recommendations

With this context, IPC offers the following feedback to the European Commission and recommendations to the European Parliament and Council as they define their positions on the proposal for a Regulation:

1. Clarify financial aspects and ensure value chain resiliency :

While IPC supports the dedication of 43 billion euros to implement the Chips Act, the source and allocation of the funding remains unclear. More clarity on future funding is necessary given the global race among governments to leverage financial incentives to attract greater investment among semiconductor companies.

Recognizing that other countries are extending even greater total financial resources to their domestic companies, we encourage a **robust set-aside for advanced packaging with a focus on smart investment through the value chain to support innovation in electronic interconnects across the value chain.**

The EU Chips Act should also strengthen Europe's capabilities in research, design and production capacity for chips **as well as the materials, components, processes, inputs and industries in the semiconductor value chain needed for their packaging and deployment.** Sufficient funding should be ensured for this for under Pillars I and II while minimising impact on other EU and existing Programmes, such as the Horizon Europe and Digital Europe programmes. In this regard, we welcome the focus of Pillar II to ensure security of supply by attracting investments into semiconductor manufacturing as well as **advanced packaging**, final component assembly and test (including internal and OSAT capabilities)

It is crucial that the Commission recognizes that **investments should benefit the entire "semiconductor value chain"**, meaning all actors contributing to and involved in the entire set of activities in relation to a semiconductor product from its conception to its end use.

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To encourage participation of companies of all sizes to the funding opportunities that will stem from the Chips Act, we recall the importance of limiting as much as possible associated administrative burden.

Financing already earmarked for example for the Microelectronics & Communication Technologies IPCEI is foundational to building the ecosystem towards first industrial deployment in the European Union. We therefore recall the importance of this IPCEI to complement the objectives of the Chips Act and the need to ensure it is sufficiently funded.

With regard to the development of IP including in advanced packaging, it will be important to further clarify the details of the pilot lines envisaged in Pillar 1 as well as the terms and conditions for access.

To ensure smart investment, we encourage the European Commission, engaging the work of a broad industrial Semiconductor and Processor Alliance, to produce a comprehensive analysis of the future needs of and gaps within the European semiconductor value chain across each segment of that value chain.

2. For a competitive Europe, enhance production investment & address skills:

The Chips Act provisions in Pillar II provide a welcome framework to attract investments in new production facilities. To stimulate innovation, further granularity with regard to the definition of European first-of-a-kind facilities would be important. This would ensure that it addresses potential innovation across the semiconductor value chain by including process innovation in addition to product innovation.

At the same time, while the potential to attract and maintain a supporting value chain and supplier base in Europe is linked to company decisions and end market demand, **the EU and Member States can play a supportive role in implementing policies to attract production activities more broadly in the EU.**

Beyond the welcome fast-track procedure outlined in the proposed Act for first-of-a-kind facilities, this implies a holistic approach to a competitive investment climate in the region. This includes **environmental & sustainability policies that are workable for industry in Europe, secure and affordable energy sources, heightened focus on enabling transitions to Factories of the Future, access to and the ability to invest in capital equipment and the availability of a skilled workforce.**

With regard to workforce, Europe is seeking to develop manufacturing capabilities that have never existed in the region. European competitors have a 20-year head start; their hard-earned know-how will be difficult to overcome. Europe's success, then, will depend on accelerating the development of expertise and leveraging that expertise to introduce

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innovations into manufacturing process. This is only possible with a robust, skilled workforce that has yet to be established.

The advanced packaging industry in Europe is likely to remain relatively small over the next 5 to 10 years, meaning that the number of workers needed to work in advanced packaging will be small as well. Trying to establish independent workforce training programs to serve this niche market will be challenging and expensive, not to mention a disservice to workers who today strive for portability in addition to upskilling. By creating a more robust workforce pipeline for the electronics industry, we will also organically create an ongoing, sustainable pool of potential workers for advanced packaging.

Aligning advanced packaging workforce training with broader electronics manufacturing workforce development also makes sense because the lines are blurring between IC substrate, embedded technologies and PCB fabrication as well as between first and second level assembly. In fact, it is likely the case that the sophistication of IC substrate manufacturing today characterizes PCB and EMS manufacturing tomorrow. For this reason, the EU should view electronics interconnection as a key strategic priority, requiring a skilled workforce. This skilled workforce will naturally pivot to the opportunities that exist as the industry evolves.

Ultimately, establishing a stronger pipeline will be a multifaceted effort, requiring a variety of curricula for use by different stakeholders training workers for different roles. The engineer will have different needs than the technician than the inspector than the operator. It is critical, however, that the curricula are developed through job task analyses to align with industry needs and that industry-recognized credentialing exists to validate worker competencies. We urge the Commission to better understand the existing mechanisms for workforce training in electronics and seek to leverage the most effective and scalable of these mechanisms to support the workforce needs of the advanced package industry.

3. Involve electronics industrial players in the Chips Act Governance

The involvement of the industrial players in Europe will be foundational to the operations and ambitions of the Chips Act. It will therefore be important to provide for structured engagement of industry with the Semiconductor Board, leveraging know-how with regard to supply chain monitoring as well as future needs and requirements.

The Alliance on Processors and Semiconductor Technologies should play a central role in this context. It is important that the Alliance begin its work and involve a wide participation of companies and industry **representing all aspects of the semiconductor value chain. Reflection of the needs of downstream electronics manufacturing industry will be important in this context (cf point 5 below).**

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4. Work with international partners

Given the complexity of global electronics value chains as well as the supportive policies being put in place to build semiconductor ecosystems in third countries and regions, it will remain important for the EU to co-ordinate with like-minded partners to ensure supply chain resiliency. The EU-US Trade and Technology Council (TTC) is a case in point.

While it is indeed not possible or desirable to seek to establish EU-based production for all elements, comprehensive gap analyses and collaboration with like-minded partners will help distinguish where additional investments are needed, where joint approaches to R&D and production could be implemented as well as the potential development of trusted supplier programmes for the sourcing of electronics for sensitive technologies.

In co-operating with like-minded partners to identify and address strategic gaps it therefore remains essential to take account of gaps and vulnerabilities across the entire electronics manufacturing chain.

5. Lay the foundations for a resilient electronics manufacturing ecosystem silicon-to-system

Semiconductor chips—as important as they may be—do not float in the air. They are useless on their own. So, too, are the advanced IC-substrates that the chips are bonded to. While they, too, are important and critical pieces of an electronic system, they are intermediate steps in a much larger process of designing and manufacturing final products and systems for use in the defence, networking, aerospace, automotive, and medical sectors. It is not until the final package is assembled—when semiconductor chips are bonded to substrates, encapsulated, and tested—that an advanced package becomes functional, valuable, and available to be integrated into electronic systems and products.

Advancements in semiconductor packaging also have direct impacts on PCB fabrication and electronic hardware assembly. The more sophisticated IC packages become, the more complex the corresponding PCB designs must become. Final system-level assembly by EMS/ODM providers is where the final product comes to life; it's where electronics are assembled, powered-on, burned-in, firmware/software loaded, and final system tests are performed. Both PCB and EMS/ODM providers play a critical role in final system delivery and availability.

A healthy, capable assembly ecosystem is needed to bring a wide variety of technologies together to manufacture finished products. Any disruptions, bottlenecks, or capability gaps within this end-to-end ecosystem leads to delays in new products and innovations, limiting the ability of Europe to manufacture the most advanced electronic systems. Therefore, it takes all elements within the supply chain—from silicon to systems—to successfully produce electronic hardware products and to meet resiliency objectives

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Hence, while we fully support investments in high-end chips as crucial for European leadership in innovation and manufacturing, so too should we support long-neglected segments of the industry including PCB and EMS that will need to innovate to meet the requirements of more sophisticated packages. Printed circuit board continue to form the base for electronics connection, including for packaged chips and embedded components, while new chip design and packaging technologies mean that demand for certain kinds of PCBs (HD Boards) and embedded PCBs will also rise in the future.

Yet despite the importance of PCBs to the functioning of electronics, the EU has a 4.4% global share of the PCB market and a risk of durably losing key skills and talent. At the same time, Europe has a strong base of Electronics Assembly (EMS); electronics partners with the know-how to manufacture electronics. While well positioned to build on the EU's strengths in Industrial /embedded electronics, European EMS, however, also have room for growth. With a majority of SME and Midcaps, size can be important to determine scale of operations, ability to invest in automation and new technologies to meet future market demands and help bring to market what begins in the lab.

Hence, if technological development takes place in one part of the chain it needs to be supported by developments throughout the chain from IC to advanced packaging to PCB and EMS. All of that is integral to make a final product - all parts of the chain need to advance in lockstep to develop a hub for technology and innovation in Europe.

IPC highlights in this respect the importance of taking a "Silicon-to-systems" approach to strengthening the industry in the longer term through the development of next steps in the EU's Industrial Strategy. This is ultimately what will build resiliency and Europe's technological sovereignty sustainably.

Conclusion

Geopolitical events have revealed the **need for greater global rebalancing of electronics value chains.** The recent chips shortages have underscored the need for Europe to act. This is particularly important as electronics constitute essential building blocks for the digitalization of Europe's strategic industry sectors and are an enabler for the green transition. Yet, as IPC highlighted in its 2021 report "Digital Directions, Greener Connections", **Europe remains significantly under-represented in many links of the electronics manufacturing value chain** following decades of production outsourcing.

IPC therefore welcomes the overall Chips Act approach to longer-term building of the chips ecosystem, the objective to **build leadership from design to production and packaging of advanced chips** while seeking to further understand the complexity of the value chain and secure vital supplies in the immediate term.

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We trust that the above comments serve as constructive inputs as next steps are taken. IPC, its members and electronics partners stand ready to work with the EU Institutions and to provide any additional information and input necessary to this process.