Integrated Photonics: a perfect example for Chips Act support

KEY MESSAGES

1. Eu Chips Act should aim to address the “earning power” of Europe for the future, by supporting the integrated photonics and semiconductor technologies.
2. It should not only stimulate the research and development activities (Pillar 1), but also support the transition of these innovations into EU-based manufacturing facilities (Pillar 2).
3. Having a full supply chain in place can lead to enduring industries that have global attraction. For integrated photonics, the full value chain is already present in Europe, including the early-stage manufacturing, all at a world-class level (Pillar 3).
4. Focus should be on further developing specialized and leading hubs in Europe so that these world-class areas of expertise give rise to positive economic spill-over effects across the whole of Europe.

BACKGROUND

Although Europe’s position is under severe pressure from global competition, from China and the US in particular, integrated photonics represents a strong business opportunity to bring strategic production back to Europe and for solution providers to innovate with new products and services. Therefore, it is of strategic importance that Europe invests in its own production capability for Photonic Integrated Circuits (PICs hereafter), based upon the strong technological footholds that are already available in many countries within its borders. An initiative to bring those capabilities together in a pan-European manufacturing system is critical from many perspectives and will be briefly outlined below.

1. Integrated photonics is enabling for many other technologies and applications, like Quantum communication, AI, sensors, and communication.
2. If Europe wants to build an asset base and create mutual dependencies on a global scale, photonics manufacturing is one of them, since many countries within its borders possess a deep and valuable knowledge and innovation capacity in that domain. Only by combining these “local” assets can Europe be in the global manufacturing game for integrated photonics technologies.

Integrated Photonics is critical for communication, sensor applications, autonomous driving as well as longer term quantum applications, as it can lead to much lower power consumption, smaller and much more sensitive systems. It is a very dynamic and vibrant industrial sector in Europe that holds the potential for huge market growth. For green photonics[1] alone, the expected CAGR value is near 20%[2] .

INTEGRATED PHOTONICS AND ITS MARKET POTENTIAL

Integrated photonics is the fusion of electronics and lighting technology. Photons have no resistance and, for example, do not produce heat. This makes integrated photonics a perfect addition to the existing electronic chips. Furthermore, integrated photonics also has many other applications, for example in sensors. Think of

[1] Green photonics comprises photonics solutions that generate or conserve energy, cut greenhouse gas emissions, reduce pollution, yield environmentally sustainable outputs or improve public health.

[2] http://ec.europa/enterprise/sectors/ict/files/kets/photonics_final_en.pdf

much more energy-efficient data centers as well as highly accurate sensors for medical scanners, wireless data transmission and measuring food quality.

With the increasing demand for bandwidth, communication between chips, and perhaps even on chips, will irrevocably become optical. This requires the use of photonic integrated circuits, or optical chips, where components such as lasers, modulators and photodiodes are integrated on the same piece of semiconductor material. Such chips are smaller, lighter, more energy efficient, potentially cheaper and have higher performance than systems consisting of individual components.

Information and communication technology will influence all aspects of our daily lives in the future, directly and indirectly. **Control over the associated value chain is thus of vital strategic and commercial importance.** The main bottleneck in that value chain has always been the hardware, the physical side of the technology.

An analysis of the leading market reports shows that the market for modules with photonic chips in a wide spectrum of applications is experiencing huge growth rates leading to a market size of US$150 billion by 2030. The market size of photonic chips (so-called PICs) for communications is forecasted at US$ 3.1 billion in 2026. At a CAGR of 23%, that would amount to over US$7 billion by 2030. This excludes the production value for the sensor market, which is more than twice as large in size. The total production market for PIC and PIC ChipLets, including assembly, is estimated at US$30 billion by 2030.

THE POSITION OF EUROPE

For integrated photonics, Europe has a mix of medium and small foundries, for InP, Silicon Nitride, Silicon (photonics) and other technology platforms, all with their specific and unique properties. Europe is the only one of the ecosystems mentioned to have invested widely in various pilot production technologies to foster these technology platforms, both at the front end, i.e. the production of PICs, and the back end, their packaging. SMART Photonics is playing a central role in all these European programs, as a uniquely positioned independent foundry, manufacturing InP chips for many global customers.

The main EU policy driver regarding integrated photonics relates to the geopolitical position that Europe envisions. The EU strives for technological sovereignty over its KETs and, in line with this, invests in R&D and in the industrial manufacturing function through, among other things, a targeted IPCEI scheme and the European Chips Act.

EUROPEAN MANUFACTURING AMBITION

A manufacturing system should consist of both a strong design capability, including world class building blocks and manufacturing capacity. A world class library, covering many properties and functionalities, ensures penetration in a broad range of application driven value chains. Lessons can be learned from the existing semiconductor industry, where Taiwan strongly invested in foundry capability and capacity early on, leading to the current globally leading position, having a market share of more than 50%. Companies such as Apple, AMD and NXP and hundreds of others make extensive use of TSMC/Taiwan for their own chips and often do not have chip factories of their own (anymore).

In the integrated photonics industry, Europe has a great opportunity to build up a similar position by investing into manufacturing capability (e.g. growing parties like SMART Photonics) and by investing into the value

chain around the manufacturing facility, as the presence of the entire value chain will have a strongly positive impact on the long term sustainability of the leading position.

In the market, the significant economic multipliers (i.e. market opportunities) lie in the design of building blocks, production and the **sharing** of production technology. It is quite possible that this will also create spin-offs in the application of PICs. Therefore, Europe should:

- Focus on core aspects of photonic chip architecture to create a world class design library of building blocks for PICs
- Develop a photonics foundry that manufactures PICs for a growing number of customers worldwide, either directly or through supply to a Semiconductor foundry, which merges the PIC with an electronic IC and Si Photonics into a hybrid IC with unique features and high-performance performance.
- Build on existing production technology as much as possible, as existing equipment can be used for this.

European investments in PIC manufacturing must be built upon existing capabilities, both in the actual production as well as in the contributing technology platforms, underlying the foundry activities. This combination of the properties, together with a strong design function, will allow Europe to manufacture the best-of-breed PICs and PIC based solutions - because of the **advanced integration.**

THE IDEAL SITUATION: A NETWORK-CENTERED PRODUCTION SYSTEM FOR PICS IN EUROPE

A network centered production system should have:

- A centrally coordinated design and integration system, making use of decentralized manufacturing functions throughout Europe
- Design and integration determine the contribution of the different manufacturing platforms, depending on functionality and application need
- Set standards to create compatibilities between different technology platforms
- Diversified value chains based on common assembly and integration standards
- Create a world class multiple technology design library

Foundries like SMART Photonics have their menu of building blocks available in a central design library. Customers can mix and match the building blocks and then assemble them into an existing advanced package or new architecture. The goal is to optimize functionality, speed up time-to-market and reduce costs.

Value creation:

- EU manufacturing standards for PICs (strengthening the value creation)
- Diversification of value chains will minimize the risk on economic failure, especially on those technologies that are currently coming from China (tele- and datacom)
- Continuous innovation, strong asset to stay ahead and stay best-in-class
- Profits stay in Europe and as a result, it can protect its own market economy
- Security aspect: manufacturing for the EU communication infrastructure with the EU equipment
- Technical expertise, innovation and early commercialization are enabled