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INDUSTRY

A Tale of Two "Chips" Acts

The year's giant semiconductor legislative packages, viewed through a photonic lens.

Stewart Wills

This year, the governments of the European Union and the United States have both stepped in to support the semiconductor business in a big way. In February, the EU unveiled the European Chips Act, which will pour €43 billion (US$42.9 billion) into state aid for big chip-fabrication plants and chipmaking infrastructure. And in July, the US Congress passed the behemoth CHIPS and Science Act, which will sprinkle some US$52 billion in subsidies and tax credits on chipmaking in the United States—and US$170 billion on research in a raft of tech-focused areas such as AI, robotics and quantum computing.

The push for these actions has come from concerns about the much-discussed semiconductor shortage of recent years, which became acute during the pandemic. But they also stem from a dose of Western politics, tied particularly to China's efforts to establish itself as a semiconductor powerhouse. What will these two chips acts mean for integrated photonics and photonic research? OPN talked with a number of interested parties to get some early impressions.

Tangible shortage

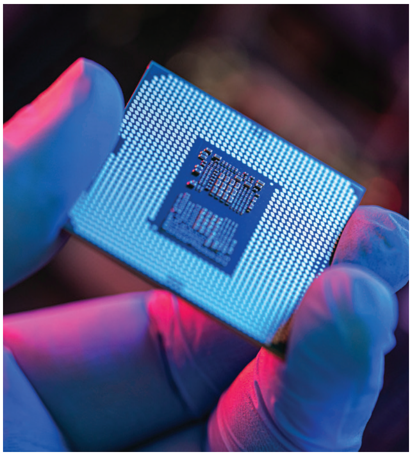
Unquestionably, researchers and companies in integrated photonics and other areas have felt the pinch of recent semiconductor shortages. Roel Baets, an Optica Fellow and a professor at Ghent University in Belgium who is also associated with imec, notes that for "all of the more system-oriented activities" that he and many colleagues have been involved in—those combining photonics and electronics—delays in deliveries of electronic components have been a significant headache. It has been, Baets says, "the first time people encountered that [situation] in their professional lives, it seems."

Michael Hochberg, an Optica Fellow and the president of US-based Luminous Computing, an early-stage R&D company working on a scalable, silicon photonics–based AI supercomputer, also says the "parts availability crisis" has complicated his company's work. Some "jellybean" parts, substrates and other components that used to be taken for granted now have "unpredictable lead times," according to Hochberg. As a result, "you have to plan a lot further in advance, and the room to correct a mistake is greatly narrowed," he says. "It adds complexity and risk."

The complexity extends to a variety of photonic areas where electronics plays a key supporting role. Optica Fellow Chris Monroe, a professor at Duke University, USA, and co-founder and chief scientist at the quantum-computing firm IonQ, notes that controlling and running the quantum systems at the heart of the company's computers requires "very sophisticated electronics" affected by availability of components. He says one family of chips important to the company's research and control systems, field-programmable gate arrays, has been "particularly tricky to get" in the past several years.

An "ecosystem issue"

While it's often glibly dismissed as a "supply-chain crisis," Hochberg sees much deeper roots in the current semiconductor shortage. "The crisis is an ecosystem issue," he says. He points in particular to the dramatic increase in demand for electronics, cars and other consumer goods reliant on semiconductor chips—in parallel with massive actions by China to stockpile semiconductor supplies and technology toward a national goal of dominance in the industry.



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While often called a "supply-chain crisis," the chip shortage is really an "ecosystem issue," says Michael Hochberg.

"Those two things together have created an enormous demand boom," Hochberg says—for "everything in the semiconductor ecosystem," from semiconductor materials themselves to packaging capacity to the relevant fine chemicals to equipment and tools, as well as for R&D and engineering talent. "State-sponsored entities in China have been on an incredible buying spree for anything they can get their hands on, up and down the semiconductor ecosystem." According to the *Financial Times*, China is pumping some RMB1.5 trillion (US$210 billion) in public and private money into replicating that ecosystem within the country's own borders—with "modest results to date."

Upping the ante with CHIPS

This geopolitical angle helps to explain the bipartisan support for the huge semiconductor aid bill passed by the US Congress in late July. The "CHIPS" part of the act—which, in an especially tortuous bit of acronym-making, stands for "Creating Helpful Incentives to Produce Semiconductors"—will devote US$52 billion to global chip manufacturers that set up or expand operations in the United States. The money comes with some strings attached, however. In particular, manufacturers who take the US funds are prevented from making high-technology investments in China or a number of other "countries of concern" for a decade.

The lion's share of the CHIPS funding will likely flow to big semiconductor firms that are increasing their investments in the United States (though some small- and medium-sized companies may also benefit). Still, Optica Fellow Volker Sorger—a professor at George Washington University, USA, and a cofounder of the photonic application-specific integrated circuit firm Optelligence—finds the act an exciting development, in part because of its bipartisan roots.

"There is consensus on this issue across party lines," Sorger says. And he thinks that, beyond the specifics of the money and its uses, enthusiasm surrounding the bill might spark activity across a variety of businesses and even reach students looking at career options. "I think this law—the enthusiasm, the excitement—will encourage students to pursue careers as photonic engineers or VLSI engineers, therefore feeding a manpower pipeline," he maintains. While Sorger

CHIPS and Science: The "Science" part

In addition to US$52 billion in aid to semiconductor manufacturing and infrastructure, the US act authorizes what's billed as "in dollar terms, the largest five-year investment in public R&D in the nation's history." Source: US House of Representatives

KEY PROGRAMS	FIVE-YEAR AUTHORIZATION
National Science Foundation (NSF)	**$81 billion**
NSF Tech Directorate	$20 billion
NSF Core Activities	$61 billion
Department of Commerce (DOC)	**$11 billion**
Regional Technology Hubs	$10 billion
RECOMPETE Pilot	$1 billion
National Institute of Standards and Technology (NIST)	**$10 billion**
NIST Research	$6.9 billion
Manufacturing USA	$829 million
Manufacturing Extension Partnership	$2.3 billion
Department of Energy (DOE)	**$67.9 billion**
DOE Office of Science	$50.3 billion
Additional DOE Science and Innovation	$17.6 billion
Total	**$169.9 billion**

acknowledges that some will frame the act as anti-China retaliation, he sees it more optimistically, as healthy competition. "It does send a signal to China and other countries," he says, "that if you want to play in the chips area, we're boosting the stakes."

Hochberg is less convinced of the positive impact of the CHIPS Act, which he worries will put the US government in the role of picking winners. "Government bureaucrats, even when they're extremely well intentioned, are not a substitute for market forces," he says, suggesting that a better approach would have been one that, for example, matched private investment with government dollars. Such a scheme, he argues, creates "a situation where market forces get to determine where the capital goes."

Apart from these considerations, there's the matter of raw numbers. "From a macro perspective … it's about an order of magnitude too small," says Hochberg. "In an industry where building a fab cost tens of billions of dollars, this is a raw amount that is not competitive" with China's effort, he believes.

A technology shot-in-the-arm?

In some ways, the "Science" part of the CHIPS and Science Act looks more intriguing for integrated photonics—and for a wide range of other optically driven areas such as AI, lidar and quantum technology. Beyond corporate welfare for chip manufacturing, the law also allocates US$170 billion to be spent on a variety of technology-focused research initiatives. These include building regional "technology hubs" and workforce development, as well as big new slugs of research funding for the US National Institute of Standards and Technology, the US Department of Energy, and a new Technology, Innovation and Partnership (TIP) Directorate at the US National Science Foundation (NSF).

Monroe sees the launch and funding of the TIP Directorate as an especially significant step. "The CHIPS Act is likely going to start flowing money into that directorate," he says, and with that funding, the agency may take a much more active role in AI, machine learning and quantum computing—even, Monroe believes, to the extent of partnerships with private companies.

"That's something that NSF historically hasn't done much of," he points out. "They fund blue-sky science, and … they're pivoting a little bit with this new directorate. And I think that's great." Sorger adds that the new NSF directorate is "for me a very strong sign," and an opportune one, suggesting a greater commitment from the agency and government in helping innovators cross the "valley of death" between fundamental research and commercial applications.

Whether basic research in the enabling technology of integrated photonics also benefits, however, will depend "very heavily" on how the law is implemented, Hochberg cautions. "I would love to see more funding for integrated optics," he says. But at present things are at a very early stage, and "I'm sure the agencies are frantically scrambling to try to figure out how to implement what Congress has asked them to do … I feel for them."

Europe's chips gambit

Across the Atlantic, meanwhile, the EU had stolen a march on the US government, unveiling its own European Chips Act on 8 February. The act aims to generate €43 billion in public and private investment, largely in cutting-edge fabs and infrastructure, in an effort similar to that of the United States to sharpen its semiconductor competitiveness—and to reduce vulnerability to outside forces.

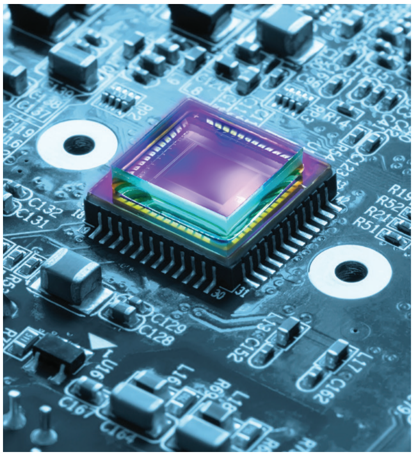
"It is a political decision," says Baets, "to pour taxpayer money into establishing infrastructure, to strengthen supply chains and reduce dependencies. That doesn't mean Europe will ever be an island. But in a global economy, perhaps dependencies have become a bit too strong." He views both the European and US chips acts as "a sort of correction" to an unbalanced global situation.

Baets acknowledges that, as with the US legislation, the €43 billion of the European Chips Act looks like "not an exuberant number" in the context of the investment cost of fabs and foundries. Nonetheless, he argues, "it's a number that will make a difference for sure"—in part because it could help focus increased private investment in this sphere.

"It would not be the right wording to call it seed money," he says. "But I would hope that we would see a chicken-and-egg situation, where there will be more private investments, also further national investments … a momentum buildup with contributions from various corners." Baets also points out that "about 10%" of the European Chips Act's price tag is "dedicated to R&D," which presumably could partly aid leading-edge technologies such as silicon photonics.

At the ECOC 2022 conference in Basel, Switzerland, Jose Pozo, Optica's Chief Technology Officer, organized a working breakfast to discuss the next steps in implementing the European Chips Act. At the meeting, 150 leading photonics executives active on both sides of the Atlantic posed critical questions to the European Commission's Colette Maloney.

"It became clear that once funding calls launch in mid-2023, the EC will have modified its definition of semiconductor production facilities to include photonics and quantum computing," says Pozo. "But with next-generation hybrid chips on the horizon, both the EC and 27 member states urgently need input from photonics companies to ensure Europe maximizes its fabrication expertise with the €43 billion of policy-driven investment available until 2030 ... We understand other world issues are already putting pressure on this funding."



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> "There is now quite a recognition that silicon photonics is a generic technology for so many other good things."
>
> —*Roel Baets*

"The US CHIPS and Science Act ... already recognises the importance photonics will play in their re-shoring manufacturing efforts," Pozo notes. "I hope there will be frank and constructive interaction between the US and Europe to avoid duplication of effort. Photonics knows no boundaries, and Optica has already offered to help drive the conversation, together with its corporate members large and small. We must get this right."

A "pivotal point" for silicon photonics?

Beyond the headline-grabbing price tag of the European Chips Act, Baets sees reason for considerable optimism on silicon photonics in Europe. He cites in particular a recent Horizon Europe Key Digital Technologies Joint Undertaking (KDT JU) call for proposals to help build industrial manufacturing capacity for silicon photonics in Europe.

While the call's actual funding number—€20 million (to be matched by another €40 million of national and in-kind contributions)—is "not huge," Baets says the effort is "quite an exciting development," as it represents "a very first step" toward building meaningful manufacturing capacity in the silicon photonics area. "In Europe we have had excellent semi-industrial R&D players" in silicon photonics, such as imec in Belgium, CEA-Leti in France, IHP in Germany and VTT in Finland, he notes. "But we are missing the industrial scale-up."

Support for such a scale-up, if it emerges and builds, would be well timed, as Baets believes that silicon photonics "is really at a bit of a pivotal point." He notes a recent study from Yole Intelligence suggesting that the value of the die-level silicon photonics market could balloon from US$152 million in 2021 to US$972 million by 2027 (optica-opn.org/news/1022-yole). The gains, according to Yole, will come from expansion not only in the technology's traditional base in high-speed transceivers for communications, but also in areas such as AI acceleration, consumer health care, lidar, sensing and more.

Communications markets will obviously continue to grow, Baets says. Yet "there is now quite a recognition that silicon photonics is a generic technology for so many other good things … It's still a relatively young technology, and it's still peanuts as compared to electronics. But there are forecasts that it will grow at a rate of 30% to 40% per year." OPN

Stewart Wills is the senior editor of *Optics & Photonics News*.