ACHIEVEMENTS AND **PROSPECTS** OF THE SEMICONDUCTOR MANUFACTURING INDUSTRY IN **POLAND**

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EUROPEAN **CHIPS ACT**

Over the past decade, the global significance of the semiconductor industry has grown substantially. The COVID-19 pandemic further exposed strategic vulnerabilities in supply chains, underscoring the critical need for a robust, localized semiconductor sector. Both, the United States and the European Union have recognized the imperative of increasing domestic chip production to safeguard economic and technological security.

In response to these challenges, on **July 25, 2023,** the European Council approved the **European Chips Act**, which officially took effect on September 21, 2023. This initiative is part of a broader effort to advance digital innovation in Europe, with the goal of boosting semiconductor production and expanding the presence of European microprocessors in the global market.

It is important to highlight that despite its significant role in manufacturing electronic devices, the **European Union's share in the global semiconductor sector remains limited.** EU policymakers have voiced concerns about an economy heavily reliant on imports. In her 2021 State of the Union address, President Ursula von der Leyen emphasized that Europe must achieve leadership in the semiconductor field, a crucial step toward 'technological sovereignty'.

The European Chips Act sets ambitious goals for the next decade, aiming to **double the EU's share in global semiconductor production from the current 10% to 20%**. However, with global demand for chips expected to double by 2030, even a significant increase in EU production will not suffice to meet future demand. Consequently, the EU plans to invest **€43 billion** from community funds, providing subsidies to the semiconductor sector through 2030. With this financial support, the European Union aims to reduce the high market entry barriers, striving to make the industry self-sufficient by the end of the decade.

The ECA itself is structured around three key pillars. The first, the 'Chips for Europe' initiative, directly addresses the primary objective of increasing semiconductor production within Europe. This section of the Act aims to facilitate the transfer of knowledge from laboratories to manufacturing facilities, promoting the industrialization of innovative technologies by European companies. The initiative will receive **€3.3 billion** in funding from the EU, which is expected to be complemented by contributions from member states. Under the first pillar, the Act will support activities such as the establishment of advanced pilot production lines, the development of a cloud-based design platform, the creation of competence centers, the advancement of quantum chips, and the establishment of dedicated financial instruments.

EUROPEAN **CHIPS ACT**

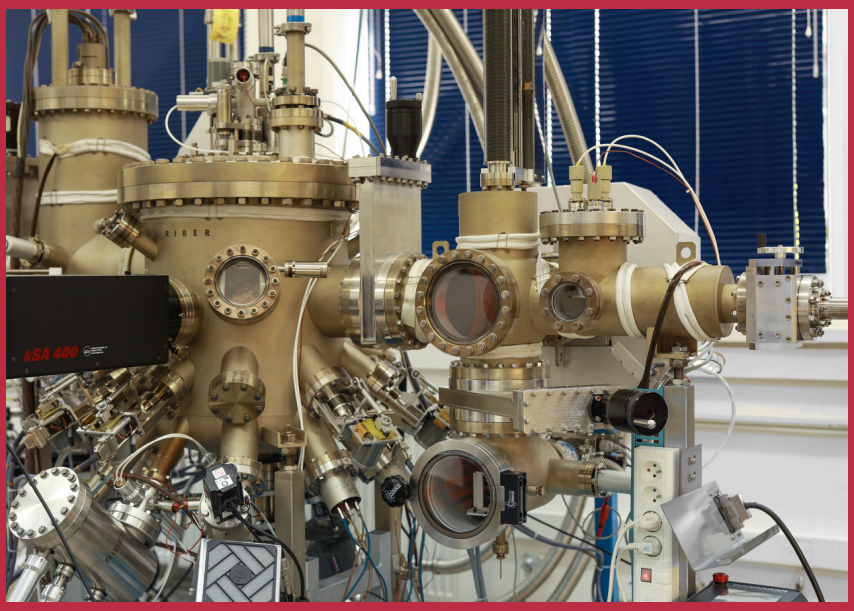
The second pillar of the European Chips Act encourages both public and private investment in semiconductor manufacturing facilities by supporting small and medium-sized enterprises (SMEs) by reducing financial barriers to entry in the semiconductor industry. However, when the ECA proposal was initially presented, the Commission made it clear that aid would only be granted to innovative facilities, described as 'first-of-a-kind'.

The third pillar of the ECA establishes a coordination mechanism between member states and the European Commission to enhance collaboration, monitor semiconductor supply chains, assess demand, predict shortages, and, if necessary, implement corrective measures. The first step in this process was the launch of a semiconductor supply chain disruption reporting system on April 18, 2023.

Overall, the European Chips Act aims to position the European Union as an attractive location for semiconductor production by offering funding and facilitating rapid business development. The ECA also outlines in detail long-term plans to maintain the EU's competitiveness through innovation, primarily achieved by investing in innovation centers and startups using both, private and public funds. The EU already has programs like Digital Europe and Horizon Europe in place, which will receive €15 billion for semiconductor-related research and development.

UNIPRESS and Łukasiewicz will create part of the pilot semiconductor production line.

Poland is already benefiting from the European Chips Act. In April 2024, the Chips Joint Undertaking selected a team including UNIPRESS and Łukasiewicz – IMiF to implement one of the four European pilot lines focused in the scope of advanced semiconductor technologies. More details can be found in further parts of this report.



Source: Łukasiewicz – IMiF

EUROPEAN **CHIPS ACT**

The European Chips Act (ECA) is a legislative package aimed at encouraging semiconductor production within the European Union. This initiative was first introduced in February 2022. Through the implementation of the ECA, the European Commission seeks to enhance market competitiveness against the industry leader, Taiwan Semiconductor Manufacturing Company (TSMC), and to reduce Europe's reliance on foreign supplies. The goal is to mitigate the risk of supply chain disruptions. The ECA is part of the **Chips for Europe** investment plan, which will continue at least until 2030, with the aim of establishing Europe as a leader in the semiconductor market. The initiative is based on **three main pillars:** research, development, and innovation; new state aid regulations designed to facilitate semiconductor production; and strategies for supply chain monitoring and intervention in case of disruptions. By 2022, Europe accounted for less than 10 percent of global semiconductor production, and the Commission hopes to increase this share to 20 percent through an investment of **€43 billion.**

Although many view the EU legislation as a response to the US CHIPS Act, both initiatives are actually efforts to **reduce dependence on supplies from Taiwan, South Korea, and China.** The latest data show that 87% of semiconductors were produced in these three countries, with Taiwan accounting for over 60% of the market. For the EU and the US, there is a clear risk in this heavy reliance on the region, particularly given the rising tensions in the Indo-Pacific. While the European Chips Act is widely seen as a step in the right direction, it also faces several challenges, including the need to rapidly scale up production capacity and attract the talent necessary to operate advanced semiconductor technologies. Additionally, the EU must navigate in a complex global environment, where other powers, such as the US and China, are also heavily investing in their chip industries.

POLISH **LAW** AND SUPPORT FORMS FOR INVESTORS

The fight to attract additional large facilities, following Intel, will be a challenge for Poland. However, experts emphasize that it is a challenge worth undertaking, as the semiconductor sector has the potential to create hundreds of thousands of jobs, not only directly in manufacturing but also among suppliers, cooperators, and within the research and development sector.

Both the European Chips Act and manufacturers like Intel are focused on selecting locations that not only provide **access to a skilled workforce** but also benefit from **environmentally friendly and economically viable energy sources.** Poland is undertaking various initiatives to reduce the environmental impact of its energy sector, with the development of renewable energy sources being a key factor. By 2030, more than half of the country's electricity is expected to come from renewable sources, primarily from PV and wind energy. According to the strategy developed in **PEP2040,** reducing the emissions of the energy sector will lead to increased competitiveness of the economy.

Significant investments are being realized in this regard in the Pomerania region, where the construction of Poland's first nuclear power plant is planned. Joint Research center (JRC) - the research and analysis arm of the European Commission, has demonstrated that the average CO2 emissions from electricity production using nuclear energy are comparable to those of hydropower and wind energy. The offshore wind farm sector also plays a crucial role. According to projections outlined in PEP2040, by 2030, offshore wind farms will generate 5.9 GW of electricity, enough to power up to 8 million Polish homes annually. The development of offshore wind energy and the construction of nuclear power plant are making Pomerania, in particular, a green region of Poland that is suitable for locating manufacturing and developing new technologies.

The global semiconductor market has experienced significant disruptions due to the COVID-19 pandemic and the war in Ukraine. The resulting **reconfiguration of the global semiconductor market** opens up opportunities for the entire Europe, including Poland - *there has been a diversification in shifting semiconductor production from the Far East to other locations, primarily in the USA and Europe. This goes beyond mere plans or announcements. We are talking about actual programs that financially support the development of large research institutes and semiconductor companies. These initiatives, backed by specific budgets, are being implemented both in Europe and the United States. This trend is already irreversible and appears highly favorable from Polish and European perspectives. Secondly, looking at economic indicators, we are in a phase of gradually emerging from the crisis. If no further unforeseen events occur, we should see moderate but dynamic growth* - says DSc Mariusz Sochacki, professor at the Institute of Microelectronics and Optoelectronics at Warsaw University of Technology, in an interview with tek.info.pl [1].

[1] *Source: https://tek.info.pl/article/3716/wyzwania_i_osiagniecia_polskiego_przemyslu_polprzewodnikowego*

POLISH **LAW** AND SUPPORT FORMS FOR INVESTORS

- When engaging in semiconductor production, it is also essential to prioritize collaboration. This opportunity has become more evident than ever, as U.S. restrictions on Chinese participation in the supply chain have created additional space. For example, GlobalFoundries has developed numerous joint ventures worldwide—such as with Qualcomm in New York and STMicroelectronics in France—to reduce investment expenditure and rapidly scale up chip production. Chip manufacturers should similarly pursue joint ventures within the European Union. Ones, that facilitate quicker establishment of new sites with lower financial outlays than operating independently, notes Łukasz Wiśniewski, a consultant from Kearney's Warsaw Office [1].

The government program aimed at boosting investments that enhance the innovation and competitiveness of the Polish economy shall be a subject of semiconductor sector revitalization. This project, titled '**Program for Supporting Investments of Significant Importance to the Polish Economy for 2011-2030',** was initiated by the **Ministry of Development and Technology.** Within its framework, the program offers funding for both, large-scale strategic investments and medium-sized innovative projects. Rewarded are initiatives that adopt modern technologies and plan research and development activities, which directly contribute to the development of the semiconductor sector. Support is provided through **grants** based on an agreement between the Minister of Development and Technology and the investor, which sets the conditions for grant disbursement and the investment implementation schedule. The program is entirely funded by the state budget.

A significant step towards strengthening the Polish semiconductor sector is also the **'National Framework for Supporting Strategic Semiconductor Investments'** project, proposed by the Ministry of Digital Affairs with an intended **$1.5 billion** budget. The program's objectives cover the entire semiconductor value chain—from design phases to production capacities. The goal is to support projects developing semiconductor manufacturing in Poland with an emphasis on investments enhancing the EU economy competitiveness, supporting sustainable economic growth, and creating new jobs. The program outlines the rules for granting public aid to investors planning to start production or open semiconductor factories in Poland that comply with European Union standards. First, the investor must submit an application to the European Commission to obtain official recognition for their project. Second, the investor must ensure that they are not subject to additional obligations imposed by other countries that could hinder effective crisis management, such as semiconductor supply chain disruptions or difficulties trading them within the European Union. The investor is also obligated to regularly inform the European Commission about any new liabilities that may arise during a crisis. To obtain assistance, the **investor must invest at least PLN 850 million** into an integrated production facility or an open EU factory within a maximum of **20 years**, and create and maintain at least **100 new jobs** throughout the entire project duration. Furthermore, the program requires investors to collaborate with research and academic institutions. Open EU factories are defined as those that manufacture semiconductors within the European Union and make their production capacities available to external companies.

[1] Kearney on the Semiconductor Market: Europe Enters the Competition. 2023, Kearney

POLISH **LAW** AND SUPPORT FORMS FOR INVESTORS

Agencja Rozwoju Przemysłu S.A. (ARP) [TN Industrial Development Agency] either directly or indirectly through its subsidiaries, manages four of the fourteen special economic zones in Poland, where it provides comprehensive services for investors, including support in selecting locations, obtaining available investment incentives, therein decisions on support, as well as ongoing assistance at every stage of the investment operation. Regardless of the above, ARP supports the PAIH (TN Polish Investment and Trade Agency) and other special economic zones' administrators (SEZs) in preparing comprehensive investment offers, even outside the areas managed by ARP. Leveraging its experience and resources, ARP, in collaboration with local authorities and other SEZ administrators, prepares grounds dedicated to strategic investments, ranging from changes in spatial development plans to the investment surrounding infrastructure implementation. ARP has the capacity not only to implement but also to manage industrial parks, an example of which is the industrial park in Kobierzyce near Wrocław, dedicated to the **electromobility** sector with the largest electric vehicle battery production facility in Europe. This translates, among other things, into ARP's key importance in financing and construction of an industrial park in Miękinia, targeting the **microelectronics industry.**

PAIH (TN Polish Investment and Trade Agency) offers comprehensive support to investors considering locating or expanding their operations in Poland, taking each time an individual approach to entrepreneurs and their investment intentions. The services provided by DI PAIH include, among others, location consulting, organization of location visits, information on investment incentives, preparation of information packages, identification of potential business partners, collaboration with startups and technology providers, organization of business meetings, assistance in building relations with research institutes and innovation centers, support in contacting administration, and post-investment care. DI PAIH also maintains a database of investment plots known as the Generator Ofert Inwestycyjnych (TN Investment Offer Generator). All PAIH services are offered to entrepreneurs free of charge.

Polski Fundusz Rozwoju [TN Polish Development Fund] is a group of financial and advisory institutions that support entrepreneurs, local governments, and private individuals, that invests in the sustainable social and economic development of the country. The PFR operating model was developed in 2017 as part of the Strategy for Responsible Development implementation. Today, PFR S.A. serves as an integrated information center for entrepreneurs, local governments, and individuals interested in development instruments. The fund assists in selecting from over 100 products, previously scattered across various Polish development institutions. PFR focuses on implementing infrastructure investments, fostering innovation, promoting entrepreneurship, supporting exports and foreign expansion of Polish enterprises, supporting local governments, executing the Employee Capital Plans program, and handling foreign investments.

COI

Centra Obsługi Inwestorów [TN Investor Service Centers] in Poland are a network of 16 units established to execute operations related to handling foreign investments, and they also serve as a 'one-stop-shop' within a given voivodship. The role of Investor Service Centers is also to back up attracting direct international investments to the regions. The Investor Service Centers in Poland are certified partners of PAIH.

Polish-Taiwanese Semiconductor Working Group

Taiwan is a key global hub for semiconductor production, therefore, the Polish-Taiwanese Semiconductor Working Group was established at the government level in September 2022 to capitalize on opportunities given by potential collaboration with this country. The primary activities of this group include initiating and strengthening cooperation with Taiwanese partners in the semiconductor industry.

Source: PAIH

POLISH **LAW** AND SUPPORT FORMS FOR INVESTORS

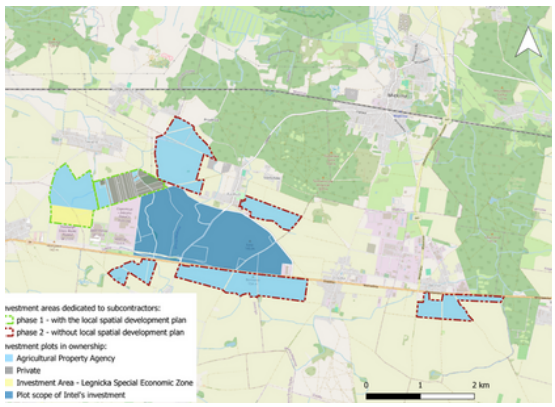
THE WROCŁAW-MIĘKINIA INDUSTRIAL PARK

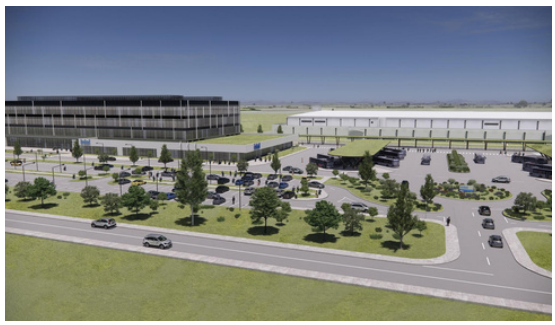
In 2023, began the preparation work on the **Wrocław-Miękinia Industrial Park**, dedicated to the microelectronics industry. The park has a planned area of approx. **500 ha** is being developed adjacent to the already existing industrial zone in Środa Śląska.

In 2023, **Intel Corporation** announced its investment in the **Wrocław-Miękinia Industrial Park**, committing to construct a Semiconductor Testing and Integration Facility. This investment value is estimated at **$4.6 billion**. Intel has expressed its intention to purchase a plot of approximately **290 ha** and to develop additional production facilities.

The development of a new road system with the modernization of adjacent national road No. 94, and a water and sewage system, including a sewage treatment plant and water intakes, will take place to meet the needs of the Industrial Park. Moreover, the energy system is being expanded in line with the future needs of the Industrial Park, which includes the construction of new high and medium-voltage lines and new nodes in the power network (GPZ).

The park's proximity to the airport, the A4 and A8 highways, and the railway network, along with its close distance to Wrocław—Poland's third-largest city and a vibrant academic hub—makes the Industrial Park highly attractive to potential investors.





***Intel** will invest in the Wrocław-Miękinia Industrial Park, the same place where an ecosystem of companies within the semiconductor production supply chain is also expected to be established.*

The park in Miękinia will become part of an ecosystem that spans Germany, the Czech Republic, and Poland.

JUSZKOWO INDUSTRIAL PARK

The land in the Pomeranian Voivodeship is a competitive terrain to the technology park near Wrocław as it is ideally suited to meet business needs.

430 hectares - total investment area

A key advantage of this land is its location. The investment area is situated within the Tricity metropolitan area, home to approximately **1.6 million people.** It is one of the largest economic centers in the Baltic Sea region. The location enables efficient communication with the Tricity being both, an abundant source of a highly educated workforce and a strategic supply location. The site is only a 25-minute drive from the center of Gdańsk and the airport, ensuring convenient access. Additionally, the plot is near the A1 motorway, close to the Rusocin junction. The site will be connected to the motorway junction by a dual carriageway, providing easy and fast access to the main transport arteries.

A comprehensive infrastructure development plan has been created to ensure the supply of electricity, gas, water, and sewage systems, and meet the needs of the semiconductor industry.

Infrastructure Development Plan:

500 MW	electricity
6,000 m3/h	gas infrastructure
40,000 m3/d	water infrastructure
35,000 m3/d	sewage infrastructure

How to get there?

3 min – from the A1 motorway
10 min – from the nearest railway station
25 min – from the Tricity metropolitan area
25 min – from Gdańsk Airport
30 min – from the Port of Gdańsk

Under the Local Spatial Development Plan, the area is designated for industrial purposes. More details about the site can be found at mobility.investinpomerania.pl

GLOBAL SUPPLY CHAIN FOR SEMICONDUCTOR PRODUCTION

There is likely no business more international than semiconductor production. The supply chains of individual companies almost always involve a dozen or more countries across Asia, America, and Europe. Due to the highly complex nature of the process, which requires strict specialization by individual companies, no country or region is entirely independent or autonomous within the entire supply chain [1].

As a result, **different countries or even regions hold leading positions in specific supply chain segments.** Currently, only about 10% of global semiconductor production takes place in Europe, and it is primarily limited to manufacturing chips using 22-nanometer technology or larger. Only two companies in East Asia, Taiwan's TSMC and South Korea's Samsung, are capable of producing the most advanced chips using 2 to 7-nanometer technology. However, the equipment necessary for this production is manufactured exclusively in Europe by the company in the Netherlands. These interdependencies within the international supply chain are in great deal and numerous.

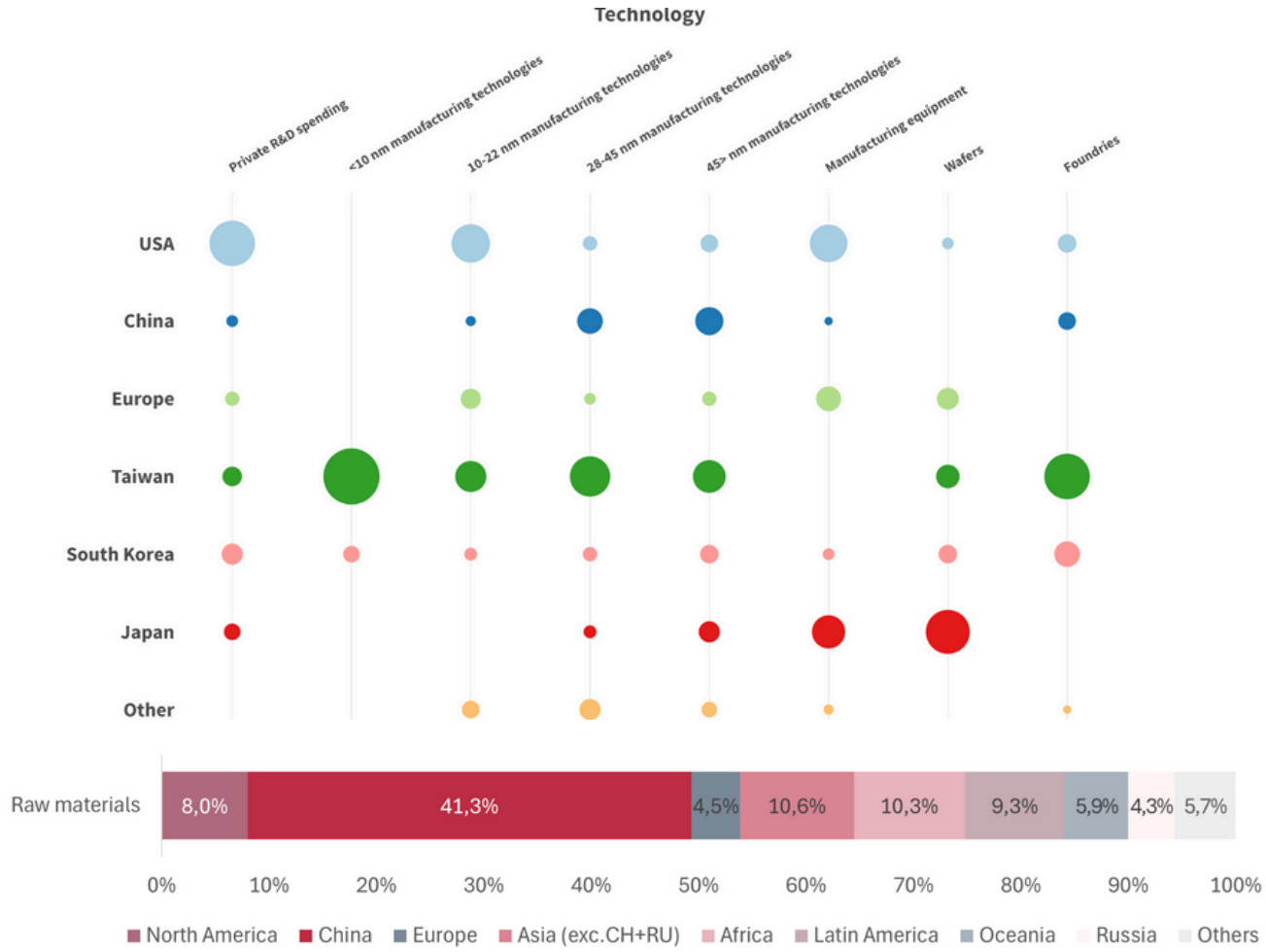
> *No country is self-sufficient when it comes to semiconductors due to the complexity, geographic specialisations and deep interdependencies characterizing the supply chain. [...] Figure 1 above and figure 2 on the next page for instance indicate that the US dominates global private R&D spending, Taiwan the foundries and most advanced manufacturing technology, Japan wafer fabrication, and China raw material inputs. Chip making, from design to production, assembly, testing and packaging is comprised of over 1 000 steps using around 300 materials including silicon wafers, gases and chemicals. Large semiconductor producers rely on up to 16 000 suppliers worldwide. A supply chain crosses the border 70 times before reaching an end user and over 50 choke points where one region holds more than 65 % of the global market share. This makes the supply chain vulnerable to disruptions such as natural disasters, infrastructure failures and geopolitical tensions* - as outlined in the 2024 report by ESPAS analysts for the EU [2].

[1] The position of the EU in the semiconductor value chain: evidence on trade, foreign acquisitions, and ownership. 2024, Joint Research center, Andrea Ciani, Michela Nardo

[2] Global Semiconductor Trends and the Future of EU Chip Capabilities, European Strategy and Policy Analysis System (ESPAS), 2024

GLOBAL SUPPLY CHAIN FOR SEMICONDUCTOR PRODUCTION

Regions share in specific segments of the semiconductor production supply chain



Source: Global Semiconductor Trends and the Future of EU Chip Capabilities, European Strategy and Policy Analysis System (ESPAS), 2024

Data on the supply chain confirms that European semiconductor-producing companies heavily rely on suppliers and customers based outside the EU. Research conducted in 2023 by the Joint Research center indicates that, on average, **nearly 80% of suppliers active in the European semiconductor supply chain have their headquarters outside the EU.** Moreover, EU companies involved in the semiconductor industry supply chain have, on average, only 37% of their clients within the EU. Among these 80% of suppliers outside the EU, the majority are based in the United States (36%), followed by Taiwan (12%), China (11%), South Korea (10%), and Japan (9%). **Awareness of these facts was one of the motivations behind the European Chips Act initiative.** [1]

[1] The position of the EU in the semiconductor value chain: evidence on trade, foreign acquisitions, and ownership. 2024, Joint Research center, Andrea Ciani, Michela Nardo

GLOBAL SUPPLY CHAIN FOR SEMICONDUCTOR PRODUCTION

Approximately **55 facilities** involved in front-end processes are located in Europe. Some of these were established decades ago—the history of the oldest ones dates back to the 1950s—when Europe's share in global production was significantly larger than it is today. Currently, **Germany** has the most front-end facilities, with as many as 17, while slightly fewer (11) are located in the **United Kingdom.** Many of the lines located in Europe specialize in niche applications or perform research and development functions.

In the pan-European aspect, the **Saxony and the Czech Republic** regions deserve to be highlighted, especially in light of numerous announcements on production expansion in Dresden and Wrocław. Dresden already hosts factories of **GlobalFoundries** (acquired from AMD), **Bosch, Infineon, and X-Fab,** while in the nearby Czech Republic, **ABB** and **Onsemi** have their plants. Soon, these facilities will be joined by the planned **Intel plant near Wrocław** and other companies located in the investment zone in Miękinia. Following the semiconductor supply chain crisis caused by the coronavirus pandemic, there have been announcements from semiconductor manufacturers about constructing new plants, with **Dresden frequently mentioned as a potential location. This region could become the European center for semiconductor production in the future.**

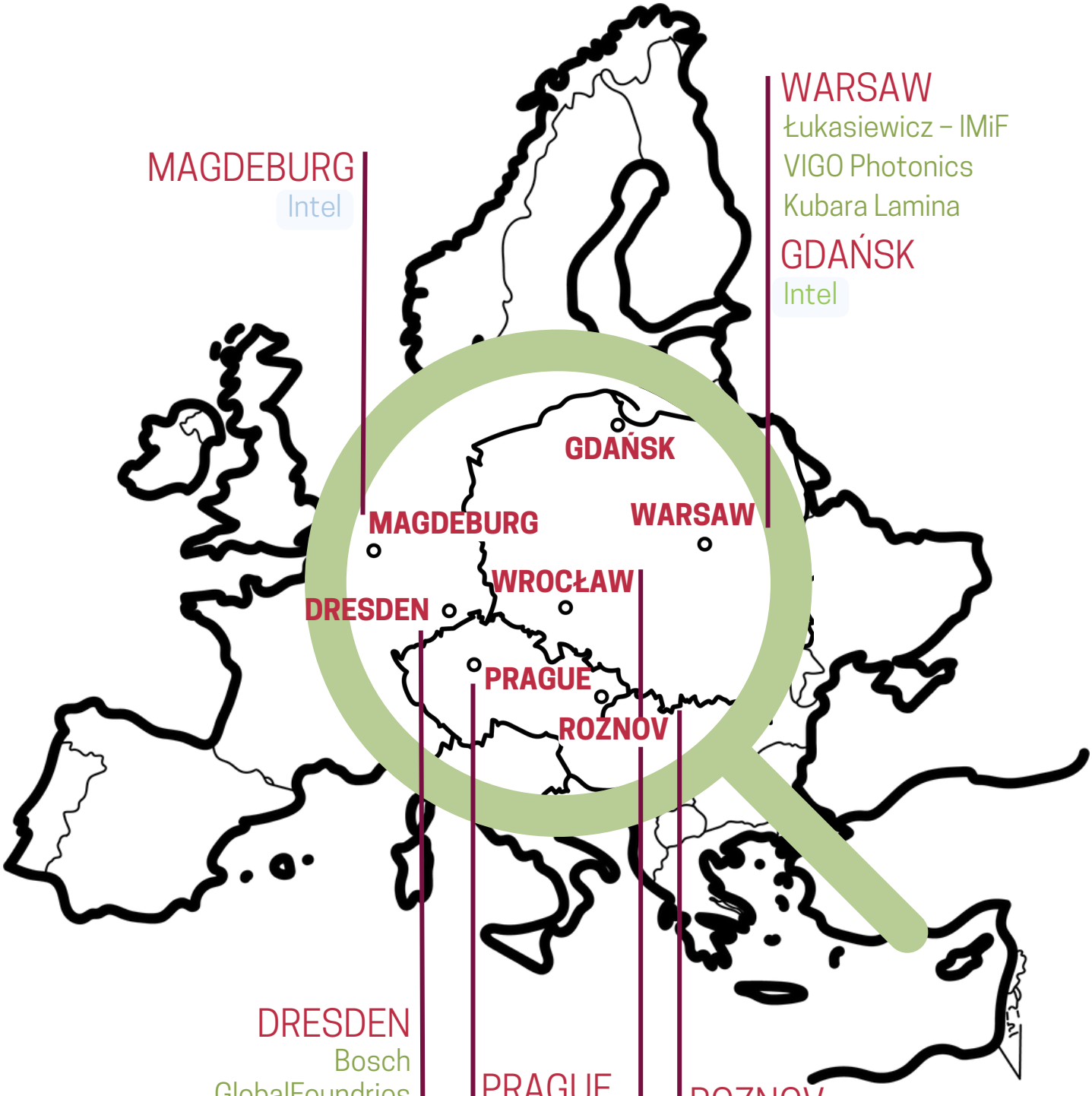
In addition to the investment announcements in Europe listed in the table below, TSMC and Samsung have also announced plans to build production units in Europe, although their locations have not yet been disclosed.

Announcements of semiconductor manufacturing lants construction in Europe

Company	Location
Global Foundries	Germany, Dresden
Global Foundries / ST Microelectronics	France, Crolles
Intel	Germany, Magdeburg
Intel	Poland, Wrocław
Silicon Box	Northern Italy
ST Microelectronics	Italy, Catania
TSMC/Bosch/NXP/Infineon	Germany, Dresden
Wolfspeed	Germany, Saarland

EUROPEAN FRONT-END MANUFACTURING PLANT LOCATIONS

POLAND CAN BECOME A BACKUP FOR THE LEADING SEMICONDUCTOR MANUFACTURING CENTER IN EUROPE, LOCATED AROUND **DRESDEN.**



MAGDEBURG
Intel

WARSAW
Łukasiewicz – IMiF
VIGO Photonics
Kubara Lamina

GDAŃSK
Intel

DRESDEN
Bosch
GlobalFoundries
Infineon Technologies
X-Fab

PRAGUE
ABB

ROZNOV
onsemi

WROCŁAW
Intel

Global Foundries
TSMC/Bosch/NXP/Infineon

legend
Planned

ELECTRONICS INDUSTRY **IN POLAND**

EMS & OEM SECTORS

It is frequently stated that Poland is a manufacturing support of Europe. In the case of the electronics industry, this statement is most certainly true.

Poland has come a long way to achieve this status. After the political transformation on the verge of 80's and 90's, the electronics industry in Poland was represented by only a few companies, often lagging behind the rest of the world in technological advancement. However, Western companies quickly recognized Poland's immense potential, sparking a wave of investments that continues to this day. One of the initial investments was a factory manufacturing **Philips** TV sets, present in Kwidzyn since mid 90's. In 2004, the plant was acquired by EMS producer, Jabil Circuit, which, along with **Lacroix Electronics**, operating since 1998, and **Flex**, present in Poland since 2000, laid the foundations for a modern **EMS** industry in Poland. Today, this industry comprises around 80 entities, which, according to estimates by **in4ma** and **tek.info.pl**, account for between **6.9% and 7.2% of European EMS production.** Poland is the **fifth**-largest EMS production center **in Europe.** [1]

Of course, it wasn't just EMS companies that invested but also **OEM**s. Other companies specializing in consumer electronics followed in Philips' footsteps. One of the most significant investors in Poland is **LG**, owning one of the largest TV factories on the Europen scale, located in Mława. TV sets are also manufactured by **Sharp** in Toruń, **TCL** in Żyrardów, and **TVP** in Gorzów. Examples of successful investments include **TRUMPF Huettinger, JOYNEXT, Diehl, TechniSat**, and many others. The development of foreign OEMs also spurred the growth of domestic companies, with a count of approx. 300 operating facilities in Poland, out of which, 10% achieves an annual turnover exceeding 25 million EUR. [2]

> *Poland is the **fifth** largest EMS production center in Europe, with a market share of approximately **7%** [1].*

[1] tek.info.pl/article/868/polska_branza_ems_na_tle_europy

[2] tek.info.pl/article/781/top_100_polskich_oem_2023

ELECTRONICS INDUSTRY **IN POLAND**

RESEARCH AND DEVELOPMENT CENTERS

The nature of production in Poland has changed dramatically since the '90s. Initially, it often involved the simplest, strictly mechanical assembly. With constant skills improvement, Polish factories were entrusted with increasingly complex tasks, including the full NPI and PCBA processes. **However, in recent years, a new trend become noticeable: more and more research and development centers are being established in Poland.** These either complement run in Poland for many years processes (such as Jabil's R&D center in Wrocław or Nippon Seiki's unit in Gdańsk) or are entirely new entities. **From designing electronic systems to manufacturing semiconductors, it's just one step in the electronics industry supply chain, and this sector could become the natural support base for the emerging semiconductor industry.**

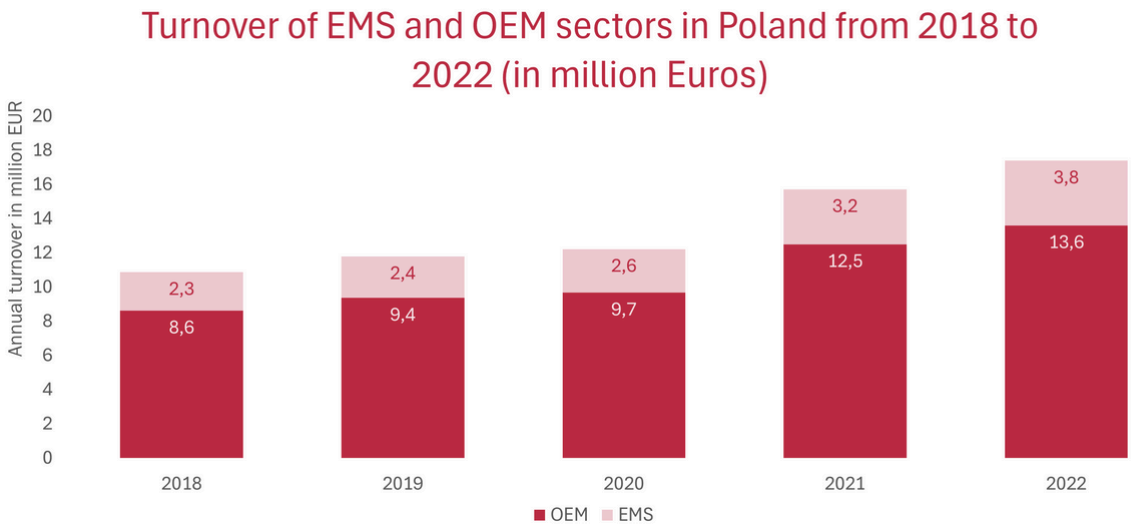
The Aptiv R&D Center in Kraków employs over 2,500 people.
Source: Aptiv

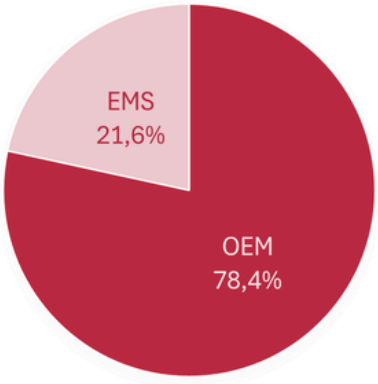
Poland has been particularly favored by the **automotive industry** which established here its design centers. One of the first and largest at the same time is the R&D unit of the American company **Aptiv** in Kraków, employing around 2,500 engineers. This center works on technologies such as gesture recognition, wireless communication, driver monitoring systems, autonomous driving, and several others. It's also worthwhile to mention that some of these technologies are subsequently produced at the manufacturing facility in Gdańsk. The German conglomerate ZF has established a similar model of presence in Poland, combining production and research functions. ZF owns three research units and two PCBA plants in Poland, working on active safety systems and autonomous driving technologies, with some of these systems being manufactured in specialized plants in Częstochowa and Wrocław. Another important example is **Nippon Seiki** concern, which develops head-up displays (HUD) in Gdańsk and manufactures them in a new factory near Łódź.[1] The automotive industry, of course, does not exhaust the topic of R&D centers' presence in Poland, as there are dozens of them in the country. Among the facilities established in recent years are highly advanced units from companies specializing in measurement equipment (**Rigaku, Pendulum Instruments, Bustec**), industrial applications (**ifm ecolink, voestalpine Signalling, Honeywell**), and many others. Also, we shall not forget the R&D centers belonging to Polish OEM companies, with a count of over hundred units, often employing dozens of people.

[1] https://tek.info.pl/article/1912/raport_elektronika_motoryzacyjna_w_polsce_2022

ELECTRONICS INDUSTRY **IN POLAND**

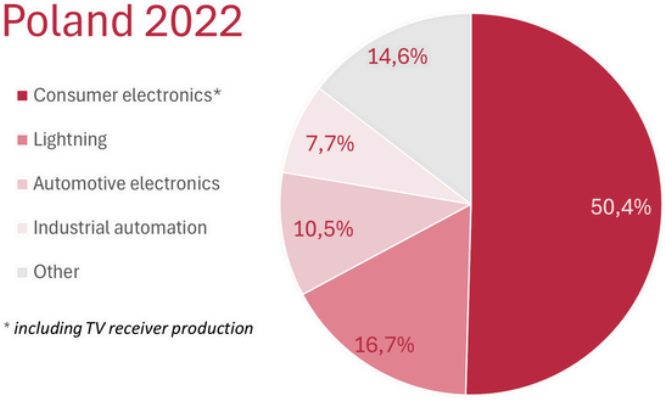
Turnover of EMS and OEM sectors in Poland from 2018 to 2022





Basic structure of the electronics industry in Poland 2022

OEM industry structure in Poland 2022



Source: tek.info.pl

KEY **OEM** INVESTORS

Aptiv
Diehl
Glamox
Nice
Heesung Electronics
Ifm ecolink
ismaControlli
Joynext
LG Electronics
LG Innotek
Lumel SA
Mobase Electronics
Scanreco
Sharp
Signify
TCL
Technisat Digital
TPV Displays
Trumpf Huettinger
Voestalpine Signaling
Woodward

Polish unit of TRUMPF Huettinger designs power supplies for lasers used in ASML machines
Source: TRUMPF Huettinger

THE LARGEST POLISH **OEMS**

AC
Apator
Bury
Elektrometal
Lena Lighting
LUG
MEDCOM
Mikronika
PCO
PIT-Radwar
Polon-Alfa
Posnet Polska
SATEL
Sonel
WB Electronics
Wilk Elektronik
Zurad

KEY **EMS** INVESTORS

Bitron
Darekon
E.G.O.
Flextronics
Hanza
Jabil
Kimball
Kitron
Lacroix Electronics
Norautron Electronics
OrbitOne
Scanfil Poland
Universal Scientific Industrial

THE LARGEST POLISH **EMS**

Assel
EAE Elektronik
Elhurt EMS
Fideltronik
InterPhone Service
Nordes
TABEMAX
TS Tronic
Vector Blue Hub

FOREIGN INVESTORS R&D UNITS

ABB
ADVA Optical
Aptiv
Arobs
Becker Avionics
BorgWarner
Bosch
Bustec
CAREL
DGS Diagnostics
Diehl
DIP Draexlmaier
Dynamic Precision
Ericsson
Etteplan
Fluke
Gebauer & Griller
Gigaset
Glamox
Honeywell
IAV
ifm ecolink
ismaControlli
Jabil
Kongsberg Maritime
LTTS
Lumel
Monroe
Nexteer
Nice
Nippon Seiki
Nokia
Pendulum Instruments
Renau
Rigaku
Samsung
Taoglas
Trumpf Huettinger
Verkada
voestalpine Signalling
VOLVO
VW
ZF

BATTERY PRODUCTION IN POLAND - A WHOLE NEW SECTOR IN JUST A FEW YEARS

Battery production is an undeniable example that a completely new, innovative industrial sector can emerge in Poland within just a few years.

*In October 2016, South Korean **LG Energy Solution** began constructing its electric vehicle battery factory in **Kobierzyce**, near Wrocław, with production starting a year later. Since then in Poland emerged plants producing lithium-ion battery chemicals, separators, copper foils, mechanical components for batteries, as well as facilities for battery recycling: within just a few years, we have created a complete supply chain.*
After only a few years of development, a completely new industry was created and Poland became the largest exporter of car batteries in the European Union and the second largest in the world.

When LG was searching for a location in Europe, the choice was quite simple: steadily developed since the mid-2000s production hub in Kobierzyce. The first phase of LG Energy Solution's expansion was an investment of 1.3 billion PLN and 700 jobs. The plant was consequently expanded between 2017 and 2019. On January 19, 2021, the decision was made to support the fourth development phase of the factory in Kobierzyce.
As a result of this expansion, the total investment will exceed **3.1 billion EUR**, with employment expected to reach up to **10,000 people**. By July 2023, the Wrocław factory achieved a level of 7000 employees, and production capacity reached 86 GWh, compared to the initially targeted 100 GWh. Batteries produced in Wrocław power electric cars like Audi, BMW, Fiat, Ford, Porsche, and Volkswagen.

The LG Energy Solution investment has sparked a series of investments, leading to the development of a complete supply chain in Poland. In the first wave of investments, immediately following LG's announcement, several companies from Asia decided to locate themselves in Poland, mainly suppliers of Korean concern. Several of which are investments of an enormous scale.

SK Innovation made its first decision to invest in separator production plants in Dąbrowa Górnicza at the end of 2018 and followed up with a second decision at the end of 2020. However, it was the news at the beginning of 2021 that electrified the industry: there will be a third and fourth plant, which will make Dąbrowa Górnicza the world's largest separator factory, pushing the total investment by the Korean conglomerate to a substantial 7 billion PLN. The first plant started operations in 2021, with the remaining facilities scheduled to be completed by 2024. The total production capacity of SK IE Technology's separators is expected to increase from the current 860 million square meters to 2.73 billion square meters by 2024.
The **Umicore** concern has been present in Poland since 2016, when it launched catalyst production in Ruda Śląska. In 2022, at a cost of 660 million EUR, it built a second plant in Radzikowice, specializing in the production of advanced cathode materials for lithium-ion batteries. At the beginning of 2024, construction began on Umicore's third plant, this time a joint venture with VW's PowerCo. By the end of 2030, Umicore and PowerCo plan to invest approximately **1.7 billion EUR** and create **1,000 jobs**. This investment, which began in early 2023, is being carried out under a new joint-venture company called **IONWAY.**

BATTERY PRODUCTION IN POLAND - A WHOLE NEW SECTOR IN JUST A FEW YEARS

One of the most significant investments in Poland is the **Northvolt Dwa** factory, located in Gdańsk, where production began in August 2023. The plant specializes in manufacturing energy storage systems (ESS) and battery systems designed for industrial applications. The new Northvolt factory covers an area of 25,000 m2 and is expected to employ at least **500** people.

In recent years, battery system production facilities like **Wamtechnik** in Piaseczno and **Johnson** Matthey in Gliwice have undergone expansion. The wave of investments still continues: at the beginning of 2024, one of Poland's longest-standing battery pack manufacturers, the German company **BMZ**, decided to expand its Gliwice plant with an investment of 103 million PLN. In April 2024, the Polish company Green Cell opened a production facility in Kraków for electric bike batteries. One of the fastest-growing Polish companies is **Impact Clean Power Technology,** which in 2024 commenced operations at its state-of-the-art **GigafactoryX.**

In a broader perspective, the growth of the battery production industry has also spurred investments across the entire electromobility sector.

In Jawor, near Wrocław, first emerged battery and electric motor factories of **Mercedes-Benz** concern, and in 2022 a €1 billion plan to build electric delivery vehicles at the same location, creating 2,500 jobs was announced. The **VW** plant in Poznań is also shifting its production profile, implementing more and more electric models, whereas, at the same time in Wrocław, **eSchwalbe** started production of electric scooters from2023. Also, electric bus manufacturers are thriving in Poland, including Polish **ARP e-Vehicles.** In Tczew, **Eaton** produces electronic systems for EVs, similar to the operations of the **ZF** Group in Częstochowa and Wrocław. The high-voltage cable production sector for EVs is also growing well, with investments in Poland by companies such as **Aptiv, Phoenix Contact e-Mobility, Kyungshin,** and **LS Cable.** Adam Drewniany, a collaborator of Elon Musk, announced in October 2023 a 30 million PLN investment in an EV harness production plant in Żelichowo.

CASE STUDY: NORTHVOLT. THE LARGEST ENERGY STORAGE FACTORY IN EUROPE

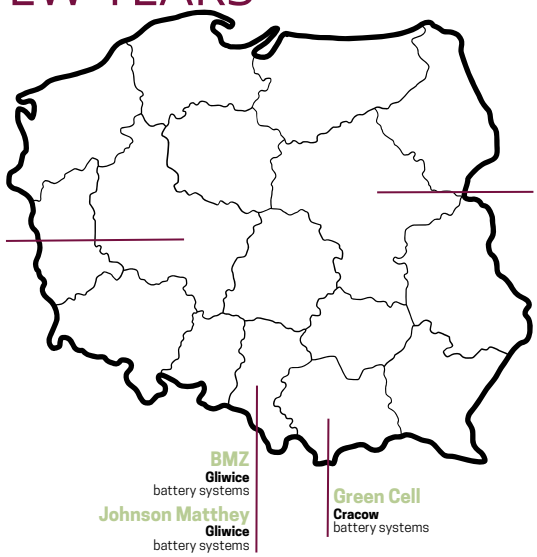
Northvolt is a Swedish company specializing in the production of advanced energy storage systems used in both electric vehicles and industrial equipment. Founded in 2016 by Peter Carlsson, a former collaborator of Elon Musk at Tesla, Northvolt quickly became a leader in the industry. Northvolt has been present in Poland since October 2018. In Gdańsk, the company opened a 5,000 m² facility producing battery modules and systems for mining and construction machinery. Simultaneously initiated were research and development projects focusing on battery systems, industrialization, and production processes. February 2021 brought to attention additional ambitious plans with the announcement of the Northvolt Dwa plant construction in the Port of Gdańsk. The state-of-the-art factory and research and development center, covering 25,000 m², were completed in 2023, and after the testing phase, commercial production began. This is now the largest energy storage factory in Europe. Northvolt does not stop at production. At the beginning of 2024, the company opened a business scaling and R&D center for IT services in Gdańsk—Northvolt Global Scaling Services (Northvolt GSS), which supports Northvolt's global operations. By 2024, it will employ over 90 people, with that number expected to grow to over 200 in the coming years. To date, Northvolt has created around 400 jobs in Poland, and this number will continue to rise with further activities. The total investment in production facilities, R&D projects, and the business scaling center has amounted to approximately 1 billion PLN.

- During the location selection process for its next investments, Northvolt was looking for a place that would provide optimal logistics conditions on one hand and access to skilled workforce on the other. The Tricity agglomeration perfectly met these requirements. The Port of Gdańsk offers direct container connections to northern Sweden, where Northvolt has launched its cell factory. Connections to other seaports in the Baltic Sea basin and Western Europe, as well as direct access into the European highway network, ensure optimized materials transportation and delivery of finished products to customers in terms of time and cost efficiency. Regarding workforce, it's worth to mention that the Tricity area is the largest academic center in northern Poland, facilitating efficient recruitment of engineers specializing in electronics, IT, and chemistry - says Mikołaj Trunin, Deputy Director, Invest in Pomerania

The Northvolt Dwa factory began serial production in August 2023.
Source: Northvolt

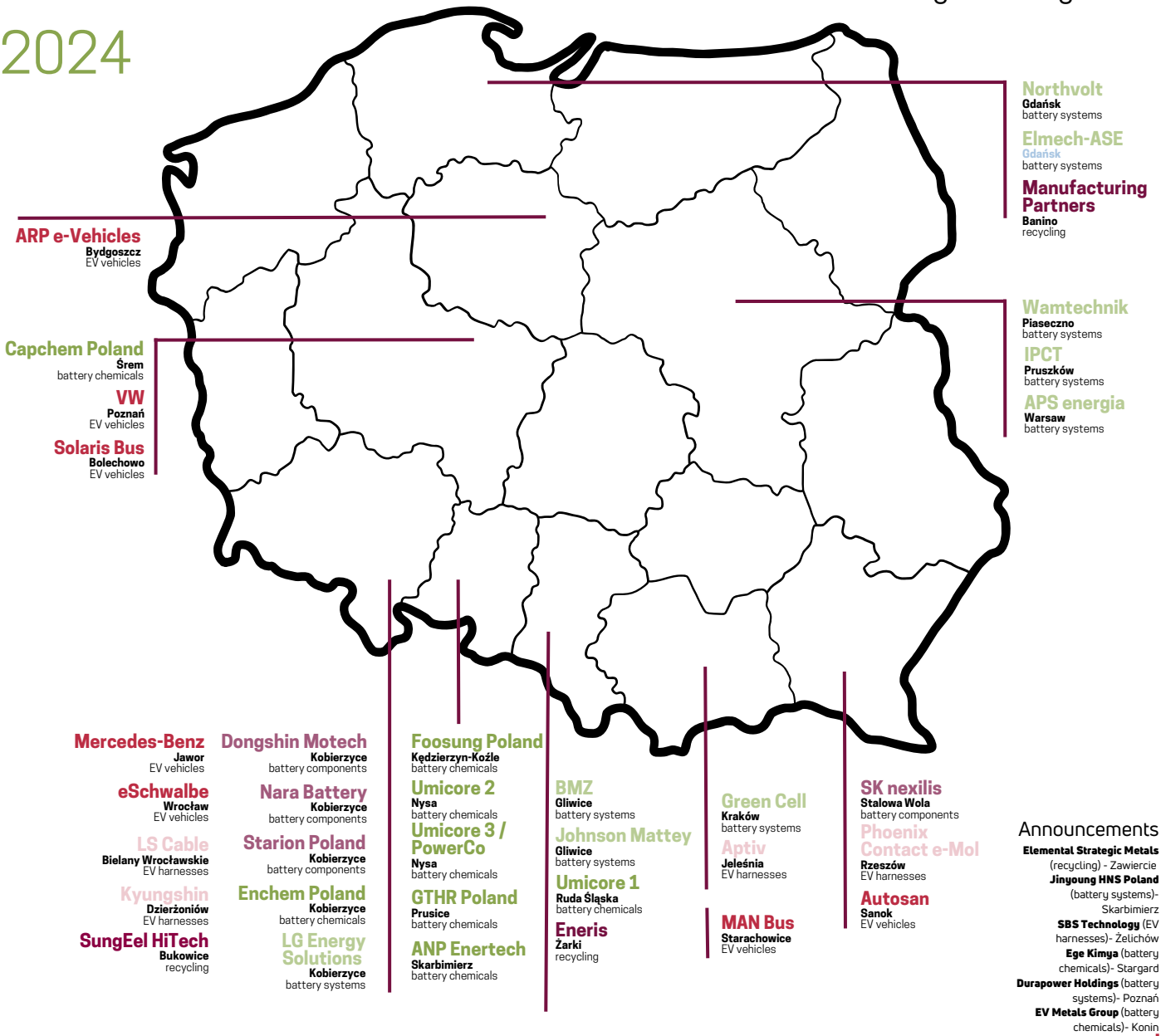
CASE STUDY: **BATTERY PRODUCTION IN POLAND** - A WHOLE NEW SECTOR IN JUST A FEW YEARS

2017



Before LG's decision to build a battery gigafactory, the battery production industry in Poland was represented by only a few companies. Since 2017, we have established a complete supply chain for Li-Ion batteries, and other sectors, such as EV production and high-voltage harness manufacturing, have also seen significant growth.

2024



Announcements

Elemental Strategic Metals (recycling) - Zawiercie
Jinyoung HNS Poland (battery systems)- Skarbimierz
SBS Technology (EV harnesses)- Żelichów
Ege Kimya (battery chemicals)- Stargard
Durapower Holdings (battery systems)- Poznań
EV Metals Group (battery chemicals)- Konin

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

KEY INVESTOR - **INTEL**

IIntel's Research and Development Center in Gdańsk was established in **1993**. Today, the Gdańsk unit boasts **4,000 permanent employees, 38 laboratories, and 6,000 m2 of space**, which has recently expanded with the opening of a modern office building known as IGK-6 (Intel Gdańsk Campus). **The Gdańsk campus is Intel's largest R&D technological center in Europe** and one of the largest of its kind worldwide, with a **leading specialization in software development.**

The initial works focused on developing device architectures for cellular networks. Gradually, the center has expanded the scope of its work, covering areas such as PC software, server software, software-defined networking (SDN), graphic microprocessors, and work on USB, Wi-Fi, Thunderbolt technologies, and audio and video processing. In recent years, the center has also been developing 5G technologies, cloud solutions, Ethernet network products, APIs, and advancements in AI and Machine Learning.

> *- Intel has been developing in Poland since 1993, and over time, the campus in Gdańsk has become Intel's largest R&D center in Europe, currently employing about 4,000 people. The division specializes in software that is present in virtually every product in Intel's portfolio, making it extremely important to the entire company. If you use any Intel product, you can be sure that at least one line of code making that product work was written in Gdańsk* - says **Mieszko Dropiński** from **Intel Poland**. *Technologies created in Gdańsk cover the entire software stack, from low-level platform software to client frameworks and workloads. An example of a comprehensive solution developed in Gdańsk is the Intel OpenVINO toolkit, including a free platform available online so that anyone can create their own AI applications, even on simple computers. This aligns with Intel's strategy of democratizing technology, and Gdańsk plays a significant role in it [1].*

[1] Source: https://tek.info.pl/article/3847/inwestycja_intel_pod_Wrocławiem_to_przelom_dla_ekosystemu_polprzewodnikow_w_polsce

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

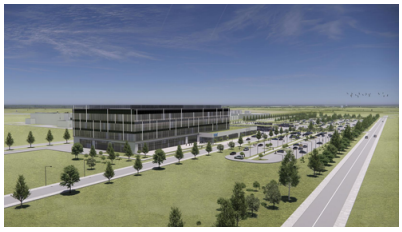
EUROPE IN THE SPOTLIGHT FOR **INTEL**

On March 23, **2021**, Intel announced a three-pillar strategy for developing integrated manufacturing capabilities called **IDM 2.0** (Integrated Device Manufacturing 2.0). First, Intel announced **expanding its own manufacturing capabilities,** ensuring company's technical excellence of products, financial efficiency, and unwavering supply chains. The other two strategy pillars include expanding collaboration with the foundry industry and expanding Intel's own semiconductor manufacturing services for external companies.

A year later, on March 15, **2022**, Intel presented more detailed **development plans for Europe.** The announcements included investments reaching 80 billion EUR over the next decade across the entire semiconductor value chain—from research and development (R&D) to manufacturing and advanced packaging technologies. In the manufacturing area, the plan covered a 17 billion EUR investment in a semiconductor factory in **Magdeburg**, Germany. Intel also announced an additional 12 billion EUR investment round in its **Leixlip** facility in Ireland. These new investments aimed to double the production capacity of the unit, enable the implementation of Intel 4 process technology in Europe, and also expand foundry services capabilities. The announcement also mentioned the **Polish design center in Gdańsk**, which was set to increase its production capacity by 50%. This plan culminated in the opening of the sixth building at Intel's Gdańsk campus in September 2023.

On June 16, **2023**, Intel announced a **4.6 billion USD expenditure to build a semiconductor integration and testing facility in Miękinia, near Wrocław.** This investment will create approximately **2,000** jobs, with production expected to begin in 2027, pending approval from the European Commission. Intel's planned investment in Poland, combined with existing facilities in Leixlip, Ireland, and the planned site in Magdeburg, Germany, will establish the first-of-its-kind comprehensive and cutting-edge semiconductor production chain in Europe.

> *- Intel has been operating in Poland for years, a country well-prepared to collaborate with Intel's facilities in Germany and Ireland. Poland is also highly cost-competitive compared to other manufacturing locations worldwide and offers an excellent talent pool, which we are pleased to help develop* - said **Intel CEO Pat Gelsinger** in June 2023. *We are grateful for Poland's support in our efforts to develop the local semiconductor ecosystem and achieve the goal of creating a more resilient and sustainable semiconductor supply chain in the EU.[1]*



Source: Intel

[1] Source: https://businessinsider.com.pl/biznes/intel-wybuduje-pod-Wrocławiem-wielki-zaklad-polska-wchodzi-do-gry-o-rynek/vd7cl3t

THE ENTREPRENEURSHIP MUSCLE

INTERVIEW WITH
MAKS DROPIŃSKI,
TECH ADVISOR AT **INTEL**

What role does the Gdańsk R&D center play within Intel's structures? What is the unit's specialization, and how does it relate to semiconductor design?
Intel has been growing in Poland since 1993, and over time, established in 1999 Gdańsk campus has become Intel's largest R&D center in Europe, currently employing around 4,000 people. The branch specializes in software, present in practically every product from Intel's portfolio, being from this perspective incredibly important for the entire company. If you use any Intel product, you can be certain that at least one code line that makes that product work was written in Gdańsk. In Gdańsk, developed are technologies that span the entire software stack, from low-level platform software to client frameworks or workloads. An example of a comprehensive solution developed in Gdańsk is the Intel OpenVINO toolkit, including its free platform available online, allowing anyone to create their own AI applications, even on simple computers. This aligns with Intel's strategy of democratizing technology, and Gdańsk plays here a key role.

The back-end technology development process has accelerated significantly in recent years—can we expect to see your latest heterogeneous integration technologies in Wrocław as well?
Semiconductor manufacturing is the most complex process in human history. To talk about it freely, you have to use some type of simplification. One such simplification is the division into two essential stages: front-end and back-end. The first of these concepts includes stages such as mask design, designing structures at the silicon wafer level, lithographic processes, etching, ion implantation, doping, electroplating, and finally creating the pathways that connect transistors on the silicon wafer. Back-end, on the other hand, is cutting wafers into individual silicon dies, which are then integrated onto silicon substrates, and advanced packaging techniques—referred to as heterogeneous integration based on interconnecting the dies. In the past, the back-end process was much simpler than it is today—typically, one die was placed on a single substrate. Nowadays, with the use of heterogeneous integration, multiple dies are connected both horizontally and in 3D. Creating the final assembly, where one die is stacked on top of another, requires the formation of a vast number of tiny connections, on the order of micrometres and nanometers. This is an extremely challenging field that requires work in high-purity cleanrooms. Subsequent steps include creating silicon interconnections, applying epoxy for protection, and adding lids. Finally, there's the multi-step process of testing the product. The facility near Wrocław will specialize in back-end operations. It's important to clarify that there are three main chip segments—components for client devices (such as PCs and laptops etc.), servers, and FPGA or graphics cards—each requiring slightly different types of back-end processes. No facility in the world can offer all types of back-end processes simultaneously or produce every component needed across Intel's portfolio. Therefore, the Polish facility will specialize in one of these types, with final decisions depending on market demand.

The decision to locate Intel's investment near Wrocław has sparked excitement among Poles and created an opportunity for the development of the semiconductor industry. Do you expect rapid growth of the semiconductor ecosystem in Poland?

On September 29, 2023, Intel announced the start of mass production using Intel 4 technology in Leixlip, Ireland. Source: Intel

Let's start by recalling that the primary goal is to increase Europe's autonomy in the semiconductor supply chain, aiming for it to represent 20% of global production by 2030—this is a direct objective of the European Chips Act. As widely known, the planned facilities in Germany and Poland, near Wrocław, along with the expansion of the facility in Ireland, are a clear expression of Intel's goal to create the first integrated advanced semiconductor production chain in Europe. These facilities are intended to collaborate, but this does not mean they will be entirely dependent on each other: the silicon wafers that will arrive in Wrocław may come from various sources across Europe, and even from non-European facilities.

Looking at Intel's other projects globally, each time, our investment has attracted an entire chain of suppliers and partners, and I believe the same will happen in the case of Wrocław. An ecosystem of other companies will undoubtedly emerge, there is space allocated for it, and there are competencies and willingness of Polish investment agencies Let's take, for example, our facility in Malaysia: in the 1970s, we started from scratch, and now the ecosystem around semiconductor production there generates 5% of the country's GDP. When considering in which elements of the supply chain Poland could be additionally competitive, it's important to look at it from the perspective of building autonomy on a European scale, and not to wonder in which market niches it should compete but where to complement the existing supply chain. One interesting area is the chemicals dedicated to semiconductor production, essential in particular in the front-end stages, which are still imported from Asia. Ultimately, for the semiconductor ecosystem in Europe to be stable, we also need to create a separate ecosystem of chemical companies. It would be beneficial for the EU to address this area in the near future, because, without additional support from government and public funds, this industry will not establish itself in Europe on its own.

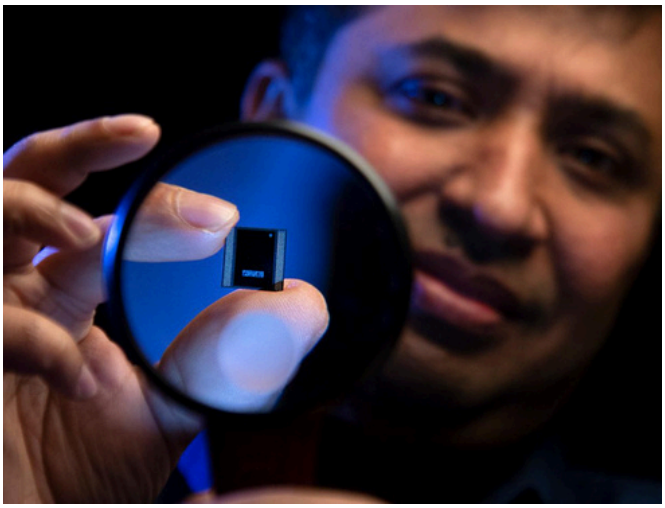
What were the key reasons behind choosing Poland as the location for Intel's new factory?

Crucial from the perspective of decision-making to locate the investment near Wrocław was the fact that Intel has existed and achieved success in Poland for 30 years. The role of the R&D center in Gdańsk within the company's structure is growing, and the facility is able to continuously develop and attract both female and male experts across a wide range of areas, meeting the needs of Intel's entire portfolio. This was an extremely important factor in choosing to locate production in a country where we have repeatedly proven our ability to acquire numerous talents from the local labor market.

The second factor is related to the goal of strengthening autonomy in Europe. We are currently expanding our facility in Ireland, and we have plans for another in Magdeburg, so the proximity of Lower Silesia was important to us. Another significant argument was the presence of other branches of the electronics industry in the region. For instance, it's worth mentioning Dell's factory, which is responsible for producing a significant portion of servers on a global scale. This is a crucial point, as companies associated with us—Dell being one of our partners—are thriving in this part of the world.

THE ENTREPRENEURSHIP MUSCLE

INTERVIEW WITH
MAKS DROPIŃSKI,
TECH ADVISOR AT **INTEL**



Intel chip made using Foveros technology
Source: Intel

It's often argued that the main obstacle to the actual development of semiconductor production is the lack of skilled personnel. Is that really the case?

When we look at the employees from other, similar Intel facilities, we can see among them male and female experts from a wide range of areas. Since Intel's inception, we have recognized that the greatest innovation comes when we bring together people with diverse experiences and backgrounds—whether in chemistry, physics, microelectronics, or even many specialties that might not seem directly related to semiconductors. The rapid advancements in front-end and back-end processes mean that what students learn today may be outdated in five years. It's only when we hire individuals with varied backgrounds and train them within our manufacturing processes that we create teams capable of developing future technologies. The focus is more on fundamental experience and mindset—it's not critically important for a specific field, like microelectronics, to be highly developed and to have a large number of male and female graduates who completed such studies. It's helpful but not essential. The rapid advancements in front-end and back-end processes mean that what students learn today may be outdated in five years. It's only when we hire individuals with varied backgrounds and train them within our manufacturing processes that we create teams capable of developing future technologies. The focus is more on fundamental experience and mindset—it's not critically important for a specific field, like microelectronics, to be highly developed and to have a large number of male and female graduates who completed such studies. It's helpful but not essential.

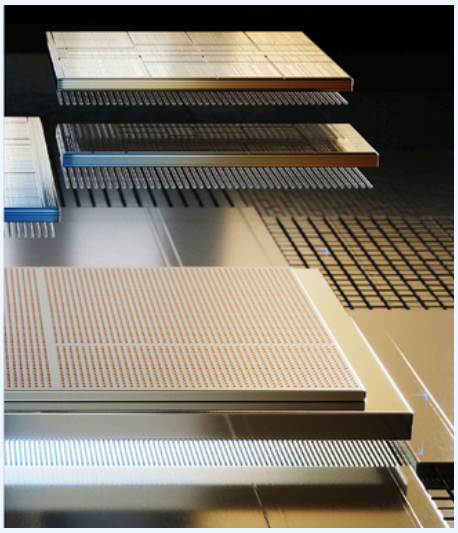
What should Poland put emphasis on to attract further elements of the semiconductor supply chain?

A future competency desired by every industry is artificial intelligence. The entire industry is currently considering how to increase the use of AI to boost efficiency. If Poland invests in education in this area, it will be well-positioned to attract more investments. Another area worth exploring is innovation and entrepreneurship. Proper understanding and teaching of these concepts from the earliest stages of education help in future life, fostering greater creativity. Innovation can be understood as the ability to make mistakes. If we are taught from childhood that making mistakes is a part of finding the best solutions, we become more innovative. People who go through an education system that allows for failure are taught true creativity, not just entrepreneurship understood as the process of starting a business. Entrepreneurship is the ability to make decisions that lead to creative outcomes, and these steps often require multiple mistakes along the way and continuous learning.

This brings us back to the question of the ecosystem. Adding the muscle of innovation to the education system is critically important not only for the investment itself but also for creating new startups. We see that in other countries, our employees, who sometimes decide to leave after several years to start their own businesses, actually create an additional, creative startup ecosystem that strengthens the semiconductor industry.

INNOVATIVE **BACK-END** TECHNOLOGIES FROM INTEL

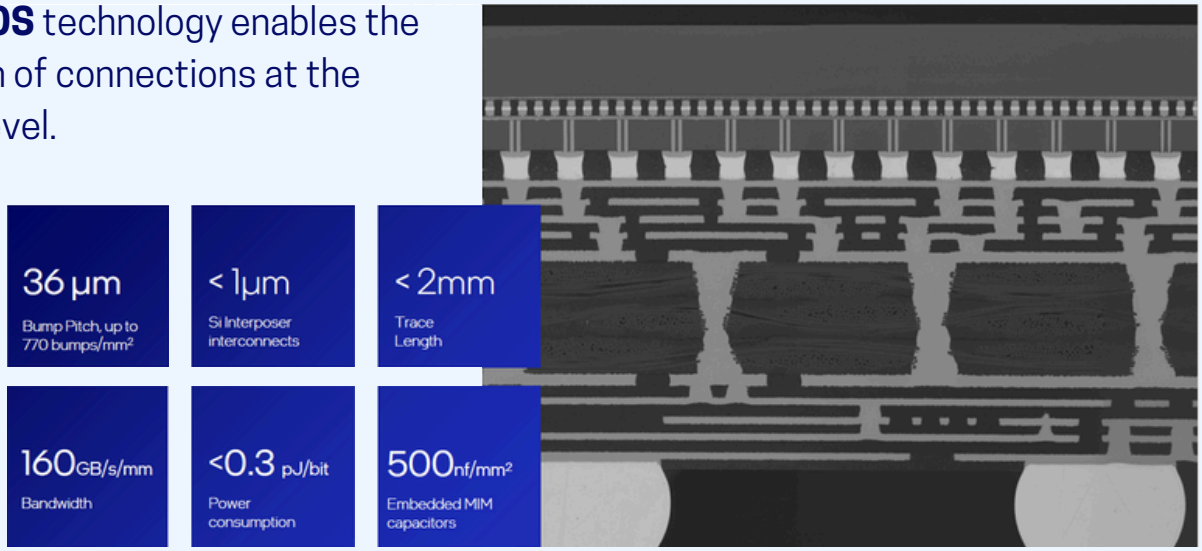
In recent years, the role of back-end technology has dramatically changed: from simply providing power and signal to enabling the creation of advanced, ultra-precise connection networks that allow for the construction of complex systems composed of multiple functional blocks, manufactured using different technological processes.



METEOR LAKE, a processor made using **FOVEROS BGA** technology, is an example of leveraging the advantages of new packaging technologies:

- Ultra-low power consumption
- The ability to choose the ideal silicon technology for each block of the system
- Flexibility in selecting and adjusting functional blocks to meet specific customer needs, thanks to a modular design
- More dies from a single silicon wafer
- Smaller final product dimensions

FOVEROS technology enables the creation of connections at the **1 µm** level.



Source: Intel

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

SEMICONDUCTOR SYSTEM DESIGN

Digital Core Design was founded in 1999 in Bytom by the Silesian University of Technology graduates. From the very beginning, the company has focused on designing specialized integrated circuits **(IP Core and SoC),** which are used in practically every industry branch —from consumer electronics and mobile devices to automotive, military, and space sectors. Over its 25 years of operation, DCD has designed more than **100 different architectures, which have been utilized in at least 1 billion electronic devices worldwide.**

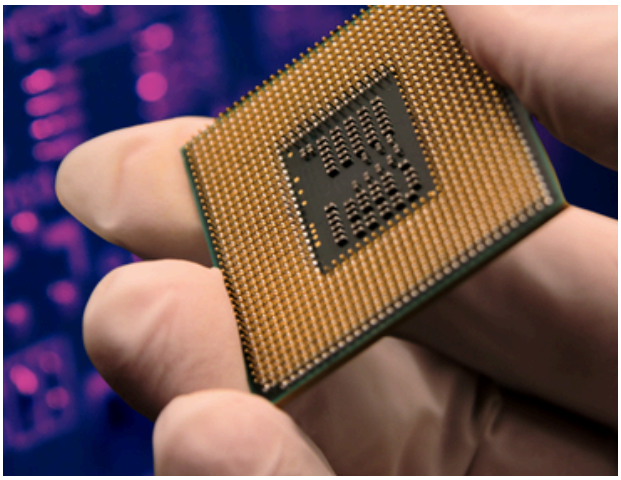
Among several employees, you can find both engineers with decades of experience and talented university graduates who, by acquiring unique skills on a national scale and enriching them with their own innovative ideas. Thanks to the mix of experience and freshness, Digital Core Design in over two decades built its brand in the global IT market, delivering its solutions to companies such as **VW, Toyota, Sony, Raytheon, Osram, Bosch, ABB, Siemens, Micron, and Honeywell.** The company's greatest achievements include:

- The first CAN XL interface in the history of Poland, dedicated to automotive apps (data transmission speed up to 20 Mbps; additional capability for implementing Functional Safety).
- 32-bit and 64-bit RISC-V processors, along with a set of peripherals and extensions (DCD is a member of RISC-V International, an organization that brings together companies developing the RISC-V standard).

-The world's fastest 8051 family processor, which, due to its highly popular architecture, is used in IoT, IIoT, and consumer electronics (the DQ80251 is over 75 times more efficient than the standard created by Intel, and with its rich set of peripherals, it is an excellent choice for power/performance projects).

- 100% secure Polish cryptographic system, Crypt-One, offering hardware-based cryptography and so-called lightweight cryptography.

- A holistic portfolio of peripherals, such as USB, I2C, I3C, SPI, and UART, which can be used both in conjunction with DCD's systems and those of external companies.



Digital Core Design has created a holistic IP Core portfolio, which includes CPUs, MCUs, and peripherals, allowing for the construction of a complete digital system. Source: DCD

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

SEMICONDUCTOR SYSTEM DESIGN

ChipCraft

The company was founded in 2016 by individuals associated with the Warsaw University of Technology. The company provides services focused on designing analog and digital building blocks of integrated circuits or entire systems. One of the company's key specializations is designing circuits for **GNSS** navigation, which is exemplified by the development of its proprietary chip, NaviSoC, as well as modules based on this chip. Currently, the company is working on the second generation, NaviSoC2, with funding support from NCBiR. In collaboration with several partners, including **Thales**, ChipCraft is also involved in the European GEONAV project, aimed at developing solutions for precise navigation. The primary goal of the project is the development and industrialization of the second phase of the GEONAV IoT solution, in line with the results of NAVISP Element 2 (TRL7).

Solidigm

Solidigm was established in 2021 following the acquisition of Intel's NAND and SSD design division by the South Korean company **SK hynix.** Solidigm is a global provider of innovative **NAND flash** memory solutions aimed at unlocking the vast potential of data, enabling customers to accelerate technological progress. The company focuses on delivering mass-storage products that meet the needs of both the consumer and corporate markets. Solidigm's product portfolio also includes a variety of SSDs that were previously part of Intel's offerings.

The company operates in 13 locations worldwide, including Gdańsk. The Polish branch supports the company's global efforts in the development of storage technology and is a key element of Solidigm's growth strategy in Europe.

Silicon Creations

The Polish branch of the American company was founded in 2006 with its headquarters in Atlanta. Silicon Creations is a designer of silicon-based IP solutions with offices in the USA and Poland, and sales units worldwide. The company focuses on designing clocking circuits (PLLs), oscillators, low-power, high-performance multi-protocol SerDes communication blocks, and high-speed LVDS I/O circuits. The components developed by the company are used in smartphones and other portable devices, consumer electronics, processors, networking equipment, automotive applications, IoT, and medical devices. Silicon Creations designs semiconductors that are mass-produced using technologies ranging from **3 nm** to **180 nm.**

The memory design process begins with the semiconductor wafer. The company relies on memory with high energy and thermal efficiency, increased durability, and reliability, which allows for storing more data and reading with fewer errors throughout the entire usage period. With the support of SK hynix, Solidigm is able to quickly achieve its technological and strategic goals. The company focuses on innovation and the development of new technologies, enabling it to compete with the biggest players in the semiconductor memory market. Solidigm is committed to developing products that not only meet current market requirements but also lay the groundwork for future innovations in mass memory.

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

SEMICONDUCTOR SYSTEM DESIGN

Phonemic

This located in Lublin company carries **RTL** projects and verification, as well as firmware for FPGA and application-specific integrated circuits (ASICs) in applications such as digital signal processing (5G, LTE), cryptography, and system-level design and integration. Among other things, the company focuses on developing IP cores tailored to specific customer needs, from the mathematical and algorithmic levels to microarchitecture, researching hardware architectures, and developing algorithms. Phonemic has developed a range of **proprietary IP cores**, including arithmetic cores (FFT, cryptography, FIR filters), complex radio processing cores (DPD, CFR), and advanced voice interface solutions (VAD).

Synopsys

Synopsys is an American corporation that supports manufacturers of integrated circuits and electronic devices by providing software for electronic design automation (EDA), pre-designed components in the form of so-called IP Core, and devices and software that aid in prototyping and testing. Synopsys solutions cover the design and verification of semiconductor systems, both in hardware and software. Founded in 1987, Synopsys currently employs over 20,000 people. The Gdańsk branch employs around 200 engineers who design integrated circuits (including analog design and layout design, which determines the arrangement of transistors) and support the development of prototyping systems and EDA tools. The engineers in Gdańsk work with technologies as advanced as 2 nm.

OmniChip

The company designs integrated circuits on behalf of foreign semiconductor firms and creates products and IP blocks for its own products. In 2022, the company conducted research as part of the Realholo project, funded by the Horizon 2020 project, which involved the implementation and verification of the digital part of an integrated circuit intended for 3D holographic displays. OmniChip also developed a platform for handling the NFC protocol. The Warsaw-based company performs tasks such as architecture analysis and design, IP design, system verification, and FPGA prototyping.

ALDEC-ADT

Founded in 1998, ALDEC-ADT is a producer of advanced software designed for **FPGA** and **ASIC** integrated circuit design. The company's main products include Active-HDL and Riviera-PRO—integrated design environment packages that support digital circuit design using hardware description languages such as VHDL, Verilog HDL, SystemVerilog, and SystemC. The Polish branch serves as the EDA software development center for the entire corporation.

POWER OF SPECIALIZATION

INTERVIEW WITH
TOMASZ ĆWIENK,
PR MANAGER AT **DCD**

What unique opportunities does Poland have in the semiconductor design industry compared to global competition?

Most Polish companies in this industry are small but highly specialized enterprises, and it is this high level of specialization that can be our competitive advantage. An example of such a company is Digital Core Design from Bytom, which has been designing semiconductor structures for over 25 years. There are few companies on the market with such unique technologies as ours, which allow us not only to offer ready-made digital architectures but also to manage projects from the prototype stage all the way to final integrated circuits. While 99% of our clients come from abroad, we still strive to convince domestic companies to use custom-designed integrated circuits tailored to their needs and capabilities. Many of them are still hesitant to rely on their own designs, opting instead for solutions from foreign corporations… which often contain IP Core developed by DCD anyway. This is why it is so important to create a Polish ecosystem of companies that, in the context of threats (such as wars or pandemics) but also opportunities that are emerging (like the European Chips Act), will enable efficient, secure, and scalable design, testing, and production of semiconductors

Which main threats does Poland face in the context of global competition in the semiconductor industry?

The main threats that Poland is facing are related to competition within the European Union and technological delays. It is planned within the framework of the European Chips Act initiative to establish competency centers in every EU member state. This means that there will be many initiatives similar to those in Poland, which could lead to the fragmentation of resources and increased competition between countries, ultimately weakening the collective potential. Therefore, it is crucial to create an integrated, unified project at the European level. If each country develops its semiconductor technologies independently, it could lead to inefficiencies. Regionalization could become a threat if there is a lack of cooperation between EU countries. The fragmentation of initiatives and the lack of joint efforts could weaken Europe's position in the global semiconductor market. Excellent confirmation of this thesis is official data on the semiconductor industry worldwide. Just 5-6 years ago, European companies accounted for about 2% of the global fabless IC manufacturer market. Last year, this figure dropped to less than 0.5%. This is why cooperation between EU member states is so important; only through synergy, rather than competition, will they be attractive to global giants from Taiwan, the USA, Japan, or China. Poland is finding its feet not only in EU structures but also in transatlantic relations, which creates opportunities for collaboration with companies from the USA. This can be a significant advantage in the context of global competition. Initiatives like the American Chips Act, which encourage the establishment of semiconductor facilities on the American continent, present an opportunity for Polish enterprises to more easily collaborate and sell licenses and other technological solutions to American partners.

> *Most Polish companies in this industry are small but highly specialized enterprises, and it is this high level of specialization that can be our competitive advantage.*

We cannot forget, however, that Poland has significant technological delays compared to more developed European countries, such as Germany. It is enough to glimpse at the area around Dresden, which is a technological hub for Central and Eastern Europe. Decades of investment, beginning in the 1990s, along with modern factories and experienced engineers, represent an undeniable potential. Therefore, strengthening cooperation at the European level and leveraging international partnerships will be crucial for Poland and Polish companies to become an important part of the European Silicon Valley. If we do not take these steps, we risk further marginalization.

But are government initiatives really the right direction to strengthen the position of Polish companies on the international stage?

Looking at the development of the semiconductor industry in other countries, it's worth considering the example of China. Three decades ago, Beijing focused on producing its own processors and integrated circuits, aiming to become independent from other markets. As a result, their products have improved in quality and now rival those produced in places like the USA. Poland should take inspiration from this example and fully leverage the potential of all domestic companies operating in the semiconductor industry. While Polish companies are doing well both commercially and technologically, government support could be crucial in securing contracts and increasing competitiveness. The Krajowe Ramy Wspierania Strategicznych Inwestycji Półprzewodnikowych program [TN National Framework to Support Strategic Semiconductor Investments] can be the answer to the need for better coordination. It is important that the team responsible for this program has the right competencies and that the institution operates free from political influence. An efficiently functioning and independent institution has the potential to significantly boost the development of technology and semiconductor companies in Poland. Integrated circuits have no political affiliations—they should be treated as a national asset.

In your opinion, in which direction is Poland heading, and does the optimistic or pessimistic vision prevail?

I am an optimist, and I view the future of Poland in the semiconductor industry with great hope. I don't focus on potential threats from other countries, such as Germany or the Czech Republic, where the creation of a Silicon Valley along the Dresden-Prague axis is planned. Instead, I see this as an excellent opportunity for collaboration. Poland can join this project, incorporating our key technological cities such as Wrocław, Katowice, Gdańsk, Kraków, and Bytom, where our company is headquartered. In the past, there was talk of a Polish Silicon Valley along the A4 and A1 highways between Wrocław and Kraków, and I believe this is still possible. Initiatives like the European and American Chips Act and planned investments by Intel create enormous opportunities for the development of the Polish semiconductor sector. Equipment, prototyping capabilities, and licenses for additional software are important, but the key factor is the idea and skills of individual engineers, which ultimately determine the final functionality of a product. In the semiconductor industry, every, even the smallest element must work reliably because the success of an entire project worth hundreds of millions of dollars can depend on it. We undoubtedly already have the know-how, so it is worth "surrounding" this knowledge and skills with equipment and institutions that will enable us to play an active role on the international semiconductor stage.

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

MATERIALS

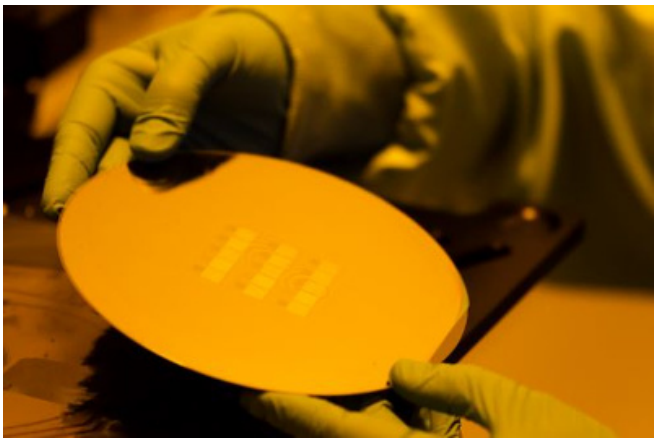
ENSEMBLE³

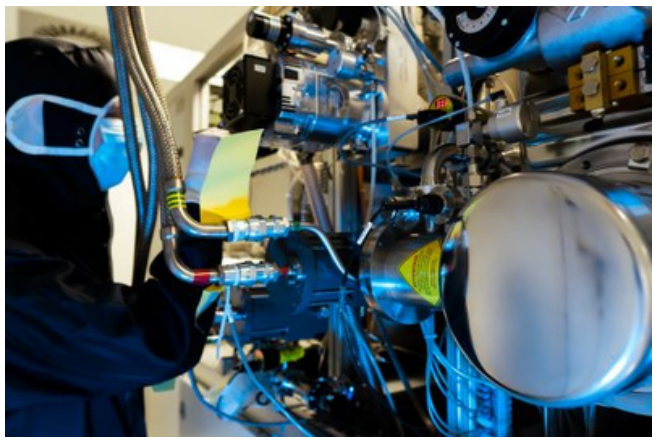
This company was founded in 2020, with its sole shareholder being Łukasiewicz – IMiF. Employing nearly 100 people company serves as a center of excellence in the fields of nanophotonics, advanced materials, and modern technologies based on crystal growth. The center focuses on the development of innovative material technologies and modern materials with exceptional electromagnetic properties, which can be applied in fields such as photonics, optoelectronics, telecommunications, solar energy conversion, medicine, and aviation.

ENSEMBLE3 produces AIIIBV monocrystals: gallium arsenide (GaAs), indium arsenide (InAs), gallium phosphide (GaP), indium phosphide (InP), and gallium antimonide (GaSb). The materials produced by ENSEMBLE3 are used in the manufacturing of microwave integrated circuits, various types of diodes (including LEDs), infrared radiation detectors, photodetectors, and more. The company also manufactures silicon carbide (SiC), several types of thermoelectric materials, and oxides used in optics and optoelectronics.

Photonics Innovation Sp. z o.o.

The company, operating under the trade name Photin, provides services in the manufacturing of thin semiconductor layers using MOCVD technology. The company produces indium phosphide in small batches, offering clients worldwide research and development services as well as small-scale production of complex semiconductor devices (InP, GaAs, GaSb, InAs).





Source: Łukasiewicz – IMiF

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

INTEGRATED DEVICE MANUFACTURER

VIGO Photonics

Vigo Photonics is a global leader in the market for mid-infrared photonic detectors. The detectors currently produced by the company are used in the world's largest research centers (measuring high-temperature plasma parameters in nuclear fusion research, measuring ultra-short infrared radiation pulses emitted by lasers and synchrotrons, spectrometers for measuring extremely low concentrations of substances) and in the development of advanced applications such as railway safety (train fault detection systems and fire detection systems), environmental protection (environmental monitoring), industrial applications (industrial scanners for temperature distribution analysis), military applications (missile guidance systems, laser warning receivers), security (detection of explosives and hazardous substances, passenger baggage screening systems), and the space industry (laser communication in open space, measurement devices for space applications).

VIGO Photonics has also added to its offering epitaxial semiconductor layers. The epitaxial layers produced at VIGO Photonics, based on indium phosphide and gallium arsenide, are the foundation for the production of devices such as quantum cascade lasers, vertical-cavity surface-emitting lasers (VCSELs), and other infrared radiation sources, as well as microelectronic components (transistors, diodes).

All products are based on the company's proprietary, unique technology. The group owns a complete high-throughput production line for semiconductor devices, from the epitaxy of complex semiconductors from groups II-VI (tellurium, cadmium, mercury) and III-V of the periodic table (indium, arsenic, gallium, antimony) through the production of detector and laser chips, to their micro-mounting and integration with electronics. The group also has its own state-of-the-art measurement laboratories, enabling fast and accurate measurements at every stage of production.

In February 2024, **HyperPIC**'s project, valued at **878.6 million PLN**, was added to the list of initiatives eligible for EU funding, with an allocation of 453.7 million PLN. This project is one of the key elements of the company's development strategy announced in June 2021, which extends to 2026. The goal of the project is to develop and implement technology for integrated photonic integrated circuits designed for mid-infrared detection, to build a complete production line, and to establish a full supply chain for these circuits. Other strategic initiatives include improving cadmium-mercury telluride (MCT) technology, developing RoHS-compliant detectors based on indium and arsenic antimonides, and creating miniature low-cost infrared detection modules for broad use in industrial applications and environmental protection.

Another initiative, InGaAs, aims to enter the existing market for short-wave infrared (SWIR) detectors, which have the potential for use in consumer electronics. The company is also advancing the technology for producing cooled and uncooled infrared detector arrays, the epitaxy of III-V semiconductor materials, the production of near-infrared sources (VCSEL lasers), and the production of epitaxial heterostructures using the MOCVD method.

Source: VIGO Photonics

VIGO PHOTONICS UNIQUE PRODUCTION PROCESS

VIGO PHOTONICS

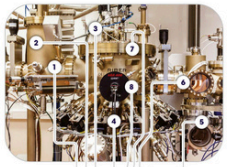
PRODUCTION STEPS
EPITAXY
PROCESSING
DETECTORS PACKAGING
INTEGRATION WITH ELECTRONICS

MBE

For production of InAs and InAsSb RoHS compliant MWIR and LWIR detectors and detection modules.

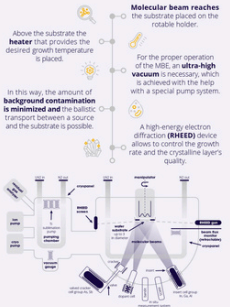
The molecular beam epitaxy (MBE) growth technology is used for manufacturing bulk InAs, InAsSb and superlattice (SL) InAs/InAsSb detectors. SL detectors made of III-V materials have strong covalent bonds, which results in a higher temperature operating range, better uniformity of the crystal, and better optical and electrical parameters.

REACTOR



1. Growth gauge
2. RGA – Residual Gas Analyzer
3. Manipulator
4. Effusion cells
5. Preparation chamber
6. Buffer chamber
7. Growth chamber
8. RHEED Screen

PROCESS

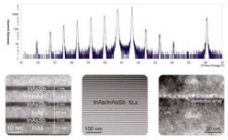


WHAT WE CREATE?

III-V InAs/InAsSb

Material details:

- **Lattice** matched to GaSb
- **Strong covalent bonds** (thermal & mechanical stability)
- **Thickness**es below critical thickness
- **Possibility to grow** on GaAs substrate via GaSb buffer
- **Strain control** during growth



VIGO PHOTONICS

PRODUCTION STEPS
EPITAXY
PROCESSING
DETECTORS PACKAGING
INTEGRATION WITH ELECTRONICS

MOCVD

For production of HgCdTe MWIR and LWIR detectors and detection modules

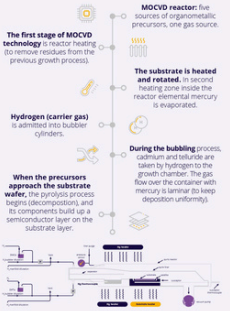
The technique used for manufacturing HgCdTe detectors is the metalorganic chemical vapour deposition (MOCVD) method. As a result, multi-layer semiconductor heterostructures are obtained consisting of more than twenty layers as a maximum, varying in terms of thickness, composition, doping and band gap broadening.

REACTOR

Metalorganic Chemical Vapour Deposition

- AIX-200 System
- Interdiffusion Multilayer Process – IMP
- To grow $Hg_{1-x}Cd_xTe$ heterostructures on GaAs substrates with in-situ doping
- (111) or (100) HgCdTe orientations possible

PROCESS



WHAT WE CREATE?

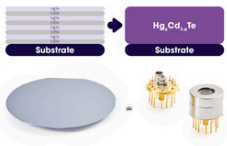
MWIR and LWIR HgCdTe epiwafers

HgCdTe has been used for production of HOT photodetectors - various modifications of PC, PV, PVM, PEM and other devices.

Material details:

- Band gap tunability 0-1.4 eV
- High performance
- Complex 3D heterostructure
- Architecture based on computer simulations
- Graded gap/doping design

IMP



VIGO PHOTONICS

PRODUCTION STEPS
EPITAXY
PROCESSING
PACKAGING
INTEGRATION WITH ELECTRONICS

PROCESS

1 Photolitography

Defines patterns in a thin layer of a photo-sensitive polymer, called a photoresist, by exposing selected areas to UV light. The pattern is transferred onto a semiconductor by etching or secondary material deposition.

- **Spin coater** – coats a semiconductor wafer with a photoresist through spinning
- **Mask aligner** – photolithography device, for alignment of a pattern on a photomask to a pattern on an epitaxial wafer

2 Pattern Etching

- **Chemical Etching (wet)**
  - In chemical solutions (acid-based)
  - Etching solutions dedicated to various materials to achieve a specific result
  - The etching effect depends on the chemical composition of the solution, the ambient conditions, the area of the material to be etched, and the density and dimensions of the pattern.
- **Plasma Etching (dry)**
  - Inductively Coupled Plasma
  - Reactive Ion Etching – ICP-RIE
- **Chemical** (by chemical reaction) **and physical (by ion bombardment) etching** of semiconductors using plasma.

3 Contact formation

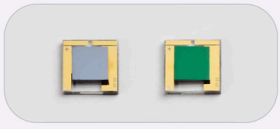
- **Metallization**
  - E-beam evaporation
  - E.g. Ti/Au, Pt/Ti/Pt/Au
  - Allows an electric contact with the semiconductor

4 Indium Bumps

In some cases, an additional medium for the flip-chip mounting.

5 Dicing

- **Dicing Wafer into single devices (chips)**
  - Automatic diamond blade sawing (dicing street 80-100 µm)
  - Manual scribing with a diamond tip
- **Cleaning the chips**
- **Visual inspection and selection**

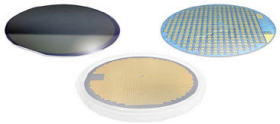


DETECTOR CHIPS

The processing aims to process semiconductor wafers with epitaxial layers into useful devices in the shape of chips.

Growth on 2" and 3" GaAs substrates

- **III-V MOCVD** – growth on substrates **up to 150 mm**
- **Currently, VIGO can process** substrates **up to 100 mm**
- **Typically, VIGO processes** wafer pieces (17 mm × 17 mm)
- **A typical chip** for a hyperhemilmmersive lens takes **up 4 mm²**
  - **2":** has a usable area ≈ 1660 mm², it gives **450 chips**
  - **3":** has a usable area ≈ 3950 mm², it gives **987 chips**

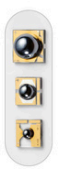


VIGO PHOTONICS

PRODUCTION STEPS
EPITAXY
PROCESSING
ASSEMBLY
INTEGRATION WITH ELECTRONICS

DETECTOR ASSEMBLY

ASSEMBLY PROCESS



1 Immersion Lens Technology

Optical immersion enables improving the detectivity of a detector in the simplest way possible – without losses, without aligning, and at a very small expense. At VIGO Photonics, the optical immersion is created directly with the use of the substrate on which the active layer of the detector is placed. This means the lens is an integral part of the device – no adhesives or other joints that could generate losses are used for its fabrication.

2 Flip-Chip

- **A process of connecting** semiconductor structure with the carrier (sapphire, silicon)
- It allows to obtain a **good electrical connection** between the elements
- Method used in VIGO – **thermocompression**
- Gluing, underfilling

3 Open Detector Assembly

- If detector cooled
  - Mounting on a thermoelectric (TE) cooler (gluing the active structure with carrier on the TE cooler)
  - Assembling the thermistor
  - Absorber container mounting,
  - Anticonvection shield mounting (for low temperature fluctuations)
- Making wire connections
- Open detector measurements
- Window assembly

4 Hermetisation

- Absorber container filling with getter
- Detector case and detector cap assembly
- Pumping the air out
- Filling with heavy, noble gases (Kr/Xe) of low thermal conductivity
- Sealing the detector
- Engraving the serial number

INTEGRATION

Integration with electronics

- **Infrared Detection Module Components**
  - Infrared photodetector
  - Signal processing electronics
  - Optics (optional)
  - Heat dissipation systems (optional)
  - Other components

Advantages

- Low noise, transimpedance, voltage PreAmplifier (+reverse bias)
- Less vulnerable to over-bias, electrostatic discharges and electromagnetic interferences
- Improved High Frequency performance
- Output signal standardization
- Effective heat dissipation
- Miniaturization
- Cost reduction
- Fast (GHz) reduction of parasitic impedances

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

INTEGRATED DEVICE MANUFACTURER / CHEMISTRY

Kubara Lamina

Kubara Lamina's manufacturing activities are based on two main pillars: the production of **high-power semiconductors** and the production of microwave products. The company produces high-power diodes and thyristors, amplitrons, absorbers, magnetrons, and circulators. The company's products are used in the power electronics and military industries, particularly in the construction of radar devices. Currently, in collaboration with WAT, ITWL, Siltec, and ZM Tarnów, Kubara Lamina is working on a new type of weapon designed to neutralize unmanned airships.

TopGaN

Founded in 2001, TopGaN was the second company in Europe to demonstrate **violet laser diodes**, and since then, it has introduced many innovative technologies in the field of **nitride-based emitters**. TopGaN produces advanced visible and UV GaN light emitters operating in the spectral range of 395-461 nm, including tunable wavelength laser diodes (external cavity laser diodes), semiconductor optical amplifiers, superluminescent diodes, and custom photonic integrated circuits.

Recent achievements of the company include the optimization of violet laser designs in the wavelength range of 415-435 nm. Additionally, by modifying the assembly process and epitaxial structure, the company achieved a lifetime of over 10,000 hours for 421 nm lasers, which is a critical parameter for these devices in the industrial market. The company is also a participant in the European TEAM TECH program, which aims to develop a monolithic, two-dimensional semiconductor laser diode array using GaN materials.

CRW Telesystem Mesko

Company specializes in R&D and production for a defense industry. It develops, implements and manufactures optoelectronic and electronic assemblies for portable anti-aircraft and anti-tank systems. It is the designer and manufacturer of unique InSb and PbS photodetectors, specialized optics and modern hybrid preamplifiers. The company has developed and implemented a number of critical production technologies, including technologies for precise assembly of optical elements and technologies for the production of photodetectors with high detection (D*>10^10 (cm*Hz^0.5/W).

CHEMISTRY

PCC Rokita

PCC Rokita has developed a technology for producing **phosphorus oxychloride (POCl3)** with extremely high purity, making it suitable for use in demanding industries such as pharmaceuticals, organic chemistry, electronics, and fiber optics. The POCl3 Solar Grade product is a response to the growing market demand for solar cells and n-type and p-type semiconductor devices. Phosphorus oxychloride is gaining popularity in the production of emitters and n-type and p-type semiconductors due to its ease of application on production lines, good process control, excellent storage stability, uniformity, and high efficiency. POCl3 Solar Grade is characterized by a very low metal content, with a total not exceeding 1 ppm, resulting in a product with 99.9999% (6N) purity. PCC Rokita SA offers POCl3 Solar Grade in specialized 1-liter containers, ready for direct use in semiconductor production and suitable for use in atmospheric and low-pressure diffusion furnaces.

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

SEMICONDUCTOR MANUFACTURING DEVICES

XTPL

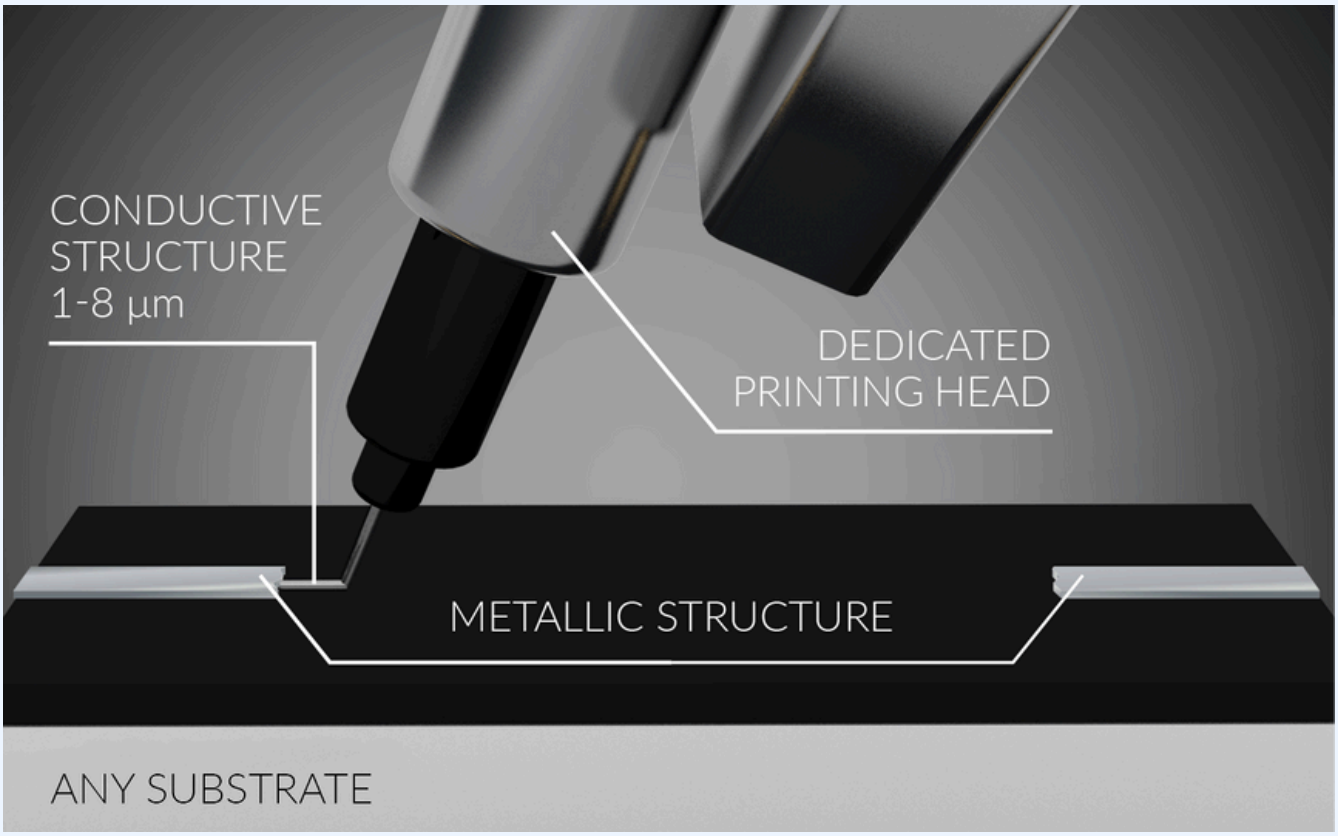
XTPL has developed an innovative printing head and dedicated nano inks that enable **ultra-precise deposition and the creation of nanostructures for applications in the semiconductor sector,** as well as in display, biosensors, and advanced PCBs manufacturing. This solution allows for the creation of structures on a micrometer scale (1–100 µm), which is required by most companies operating in the semiconductor market. XTPL's method enables the addition of material to achieve desired patterns in a single-step process with submicron precision and simplicity. **This solves several key issues associated with the currently standard subtractive semiconductor manufacturing technology—photolithography.** The main drawbacks of photolithography are its complexity and multi-step approach. The process is also expensive, and the need for masking limits its versatility. Photolithography requires an extremely clean substrate and ideal temperature conditions, free from any contaminants, liquids, or environmentally hazardous factors. It can only be used to create appropriate patterns on flat surfaces. XTPL's additive technology eliminates most of the drawbacks of photolithography, as it does not require special external conditions and can be used on most substrates, including uneven ones. Unlike the subtractive photolithographic method, XTPL's additive method is free from complexity. XTPL's solutions meet all the requirements of the modern semiconductor sector: high throughput, miniaturization of spot size, ultra-precision, control over edge roughness, elimination of costly masking, reduction of material usage and waste, reducing process complexity, shortening production time, and reducing overall costs.

When combined with nano inks tailored to the semiconductor sector, XTPL's technology can serve as an alternative to photolithography in various subsectors of the electronics industry, including printed electronics, displays, and biosensors. In January 2022, XTPL announced a collaboration with **Nano Dimension** to develop a new conductive ink formula based on metallic nanoparticles, aimed at the PCB market and Additively Manufactured Electronics (AME). XTPL's printing module is also a crucial component of a prototype industrial device for advanced packaging applications, being developed by a Taiwanese technology company. Similarly, XTPL's technology is currently being evaluated by the Korean display manufacturer HB Technology for its potential use in the construction of next-generation OLEDs. Additionally, it is being tested by an American client, one of the largest producers of industrial machinery for semiconductor and flat panel display (FPD) manufacturers.

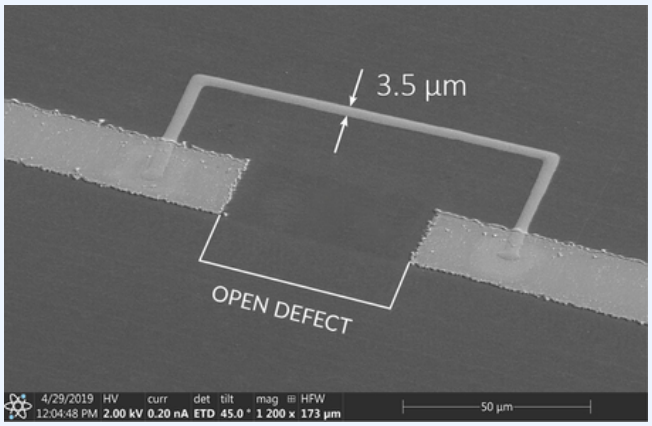
ASYS Polska

ASYS Polska is a subsidiary of a German company that has been producing industrial robots for the semiconductor industry for over 15 years, meeting the highest cleanliness standards and operating even in vacuum conditions. The company supplies robots to clients such as ASML, VDL Groep, and Bosch Polska. In January 2024, ASYS Polska announced that it will invest 20 million PLN to expand its facility with a new production hall and equipment for robot manufacturing.

ULTRA PRECISE DEPOSITION TECHNOLOGY FROM XTPL



A key achievement of XTPL is its innovative **Ultra Precise Deposition (UPD) technology.** The XTPL printing head, equipped with a special nozzle, deposits ink onto the substrate and allows for the creation of designed structures with widths as small as **1 µm.** For comparison, most of the electronic material printing methods available on the market struggle to achieve a resolution of 20 µm, with only a few manufacturers claiming to reach around 10 µm.



Source: XTPL

XTPL's solution can be applied to various types of substrates, including flexible or curved ones. Using UPD technology, it is possible to print different shapes, including simple lines, patterns, and microdots.

Insoptics

Insoptics produces and develops spectroscopy devices for plasma processes such as thin film deposition, plasma etching, PECVD, atmospheric plasma etc. Insoptics offers products such as devices such as monochromators, spectrometers and spectrographs.

Instytut Fotonowy

A company designs prototypes and unique devices used in semiconductor research and development processes. The company designs semiconductor characterization devices, photoelectrochemistry and electrochemistry equipment and accessories, various types of spectrometers, specialized light sources, etc.

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

SEMICONDUCTOR MANUFACTURING DEVICES

TRUMPF Huettinger

TRUMPF Huettinger, one of the key investors in the electronics industry in Poland, is collaborating with **ASML**, a leader in semiconductor manufacturing devices, and **Zeiss**, a leading company in optical systems, to develop **laser systems that are the heart of semiconductor manufacturing machines.** With a history spanning over 100 years, the TRUMPF group has been present in Poland since 2007, when it acquired Advanced Converters (AC), a company founded by a group of scientists from the Warsaw University of Technology. TRUMPF now employs nearly **1,700** people in Poland and generates revenues of approximately **1.5 billion PLN.** Integrated circuits with logic and memory systems have structures measured in nanometers and can be produced through complex laser beam exposure processes. The traditional method, using ultraviolet laser beams from excimer lasers, is increasingly proving insufficient. In the future, smaller structures will only be achievable using even shorter wavelengths in the extreme ultraviolet (EUV) range. In Poland, TRUMPF Huettinger develops high-power supplies **(plasma generators)** that precisely control the conditions for plasma excitation in a vacuum chamber, as well as power supplies for TRUMPF lasers and machines. Half of the production in this area in Poland meets the internal demand of the group in Germany, with other partners including companies such as Airbus, Apple, and Japanese (Tokyo Electron) and Korean firms. The plasma generators developed in the group's Polish plants are used in the production of advanced electronics (semiconductors, coatings on smartphones, diamond drills), as well as photovoltaic panels. a production of advanced electronics (semiconductors, coatings on smartphones, diamond drills), or photovoltaic panels.

TRUMPF Huettinger's plasma generators play a paramount role in the actual production of integrated circuits. The quality of the power supply determines the quality and precision of the generated plasma, which is then used for doping (ion implantation), deposition (PECVD, ALD), or removal (plasma etching) of various materials used in the manufacturing of semiconductor integrated circuits. Another challenge in the electronic process chain, following the exposure and formation of interconnections on silicon wafers, is the separation of the wafers into individual integrated circuits. To obtain the smallest possible cutting gaps, high edge quality, and to avoid damaging sensitive integrated circuits due to high temperatures, TRUMPF's ultrashort pulse lasers are used during the separation process. The company's induction power supplies are also used in the synthetic production of crystals, enabling uniform and stable temperature distribution.

> *We are well aware of the global nature of the semiconductor industry. Nevertheless, Europe is still present in the market and can be an important player, for example, thanks to the involvement of TRUMPF and innovations developed in Germany and Poland. It uses its international presence, strong ties with customers, and technological knowledge to remain competitive on a global scale* - says **Bertold Schmidt, CTO** of the **TRUMPF** group in an interview for isbtech.pl

Source: https://www.isbtech.pl/2024/04/trumpf-inwestuje-ok-10-rocznych-przychodow-w-rd/

OTHER

QNA Technology

QNA Technology focuses on developing the technology and production procedures for **semiconductor nanomaterials (so-called quantum dots)**, which are free from heavy metals and used in display manufacturing. QNA stands out by its comprehensive approach to the process from the synthesis of nanomaterials to their implementation in industrial applications, therefore the company has developed technologies for quantum dots surface modification and formulations for semiconductor inks basing on quantum dots, enabling customers to print semiconductors on various substrates using a range of printing techniques. A quantum dot is a semiconductor nanocrystal, measured in nanometers, which structure is composed of an inorganic semiconductor core (responsible for generating and absorbing light), a protective shell that shields the core from external factors, and an outer organic shell that serves as an interface between the quantum dot material and the material in which it will be embedded. Subsequently, the quantum dots are delivered in the form of ink, allowing for the printing of semiconductors on various types of substrates, including flexible and transparent ones. QNA Technology's main product is DeepBlue.dots—blue quantum dots free of heavy metals and rare elements, emitting light at a wavelength of 440 nm. The company is currently working on PureBlue.dots, with a peak emission of 455 nm. In August **2022**, the PureBlue.dots quantum dots were used in the construction of a QDEL diode prototype by the German Fraunhofer Institute. The company's technology is also in the validation process with a client in Japan. On February 5, **2024**, QNA completed the construction of the first version of an experimental pilot line for quantum dot synthesis.

Noctiluca

Noctiluca specializes in the development and production of **advanced chemical compounds** (high-performance materials) that are key elements **responsible for luminescence in OLED displays and light sources.** These compounds' parameters determine the efficiency of converting electrical current into light, the quality of images displayed in OLED technology, color saturation, and brightness. These are compounds that emit light through Thermally Activated Delayed Fluorescence (TADF) for use in 3rd and 4th generation OLED technology. Noctiluca also develops dedicated auxiliary materials for these compounds, which make up the majority of the emissive layer in OLED displays, offering its clients a complete solution consisting of an emitter, sensitizer, and hosts. All these elements are encapsulated within a special diode, forming the OLED panel and then the matrix, ultimately resulting in a finished OLED display that emits the image viewed by the user.

Currently, Noctiluca is working on the fifth generation of OLED emitters, based on PST and PSF technologies, aimed at extending the lifespan of blue pixels while achieving higher luminous efficiency than today's standards. The company is also continuing its work on new materials for the entire emissive layer and is involved in projects related to printing technologies (PVD, IJP).

Noctiluca boasts of its collaborations with **LG Display, Inkbit, Inuru, TCL,** and **ITRI.** In July 2023, the company signed an Evaluation License Agreement with the world's largest consumer electronics manufacturer from the USA (California). The company maintains and develops relations with 8 of the 10 largest display companies in the world.

SEMICONDUCTOR MANUFACTURING ECOSYSTEM **IN POLAND**

Intel Technology Poland
USA
4 000
1 244.0 million PLN

SK hynix NAND
South Korea
320
133.8 million PLN

Silicon Creations
USA
65
39.1 million PLN

ChipCraft
Poland
11
1.5 million PLN

VIGO Photonics
Poland
212
67.9 million PLN

Kubara Lamina
Poland
128
27.7 million PLN

TopGaN
Poland
31
1.0 million PLN

Trumpf Huettinger
Germany
1 700
1 546.1 million PLN

XTPL
Poland
45
12.8 million PLN

nearly 9,000 employees
3.2 billion PLN in annual revenue

Synopsys Poland
USA
172
50.1 million PLN

Aldec-ADT
USA
61
19.1 million PLN

QNA Technology
Poland
23
3.9 million PLN

Noctilluca
Poland
16
0.7 million PLN

Intel Miękinia
USA
2 000
PLANNED

legend
Design
IDM
Manufacturing Devices
Software
Others
OSAT

UNIQUE TECHNOLOGIES OF VIGO PHOTONICS

INTERVIEW WITH
EMIL BATOROWICZ
MARKETING MANAGER
AT **VIGO PHOTONICS**

Within what timeframe the company can develop such advanced technological competencies? Does this process resemble 'experimenting' and 'research works' with uncertain outcomes? Under what conditions could the technical competencies of Polish companies be developed faster?

The origins of our technology date back to the 1970s when Antoni Rogalski and Józef Piotrowski were conducting their work on it. Today, the company is led by Professor Piotrowski's son, Adam, who based his PhD thesis on implementations carried out in our laboratory in the early 2000s. You could say that we've been perfecting our technology for 35 years, with the following years dedicated to refining and developing physical processes in our reactors, implementing new reactors, improving the processing of grown epitaxial layers (photolithography, etching, metallization, cutting), refining production processes such as the assembly of complete detectors, integration of detectors with electronics, and the miniaturization of our products.If a developed semiconductor industry existed in Poland, our work on the technology we use would have undoubtedly progressed faster. In a way, those who played key roles in perfecting the technology, often employees from WAT and the Warsaw University of Technology, are largely self-taught. They develop theoretical knowledge and implement it in practice. Without an ecosystem of entities focused on semiconductor production, it is difficult to find workers with practical skills and to refine or develop these skills across different companies, and developing such a demanding technology requires combining knowledge from many fields, such as physics, chemistry, and optoelectronics.

On the other hand - perhaps partially due to this peculiar isolation - absolutely unique technologies have been developed at VIGO Photonics. The process of depositing cadmium-mercury telluride is very demanding, requiring experience and know-how to maintain the consistency required by the industry, and few companies attempt to carry it out. As a result, our detectors produced using this process are unique on a global scale.

Furthermore, the technology we've developed in recent years for creating immersion detectors is also unique. Most detector manufacturers use lenses, integrated with adhesive, to enlarge the active area. In our case, it's a monolithic structure; the semiconductor itself is precisely shaped using advanced mechatronics—again, a technology independently developed by our company. Although we openly publish scientific papers on the subject, no one has yet succeeded in recreating this technological process.

Source: Vigo Photonics

UNIQUE TECHNOLOGIES OF VIGO PHOTONICS

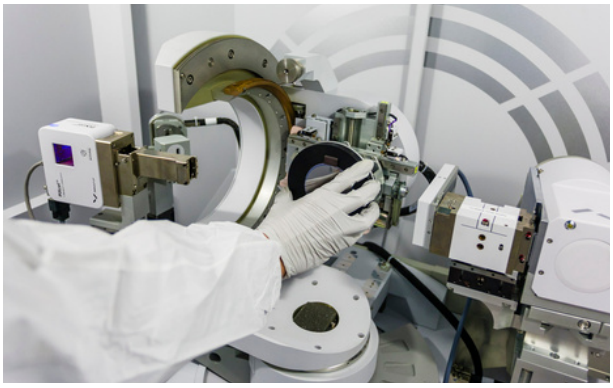
INTERVIEW WITH
EMIL BATOROWICZ
MARKETING MANAGER
AT **VIGO PHOTONICS**

Thanks to the HyperPIC project, Vigo Photonics is supposed to become the first in the world manufacturer of photonic integrated circuits for the mid-infrared (MIRPIC) range, thus entering the consumer electronics market. In this regard, will new technical competencies be required for this project? And from the point of the average user of, for example, a smartphone user, what new features can be expected?

Mid-infrared integrated photonics is a unique technology, and until now, no one has developed integrated photonic circuits in this infrared range. Some global corporations are working on integrating circuits operating in the near-infrared range, but that spectrum does not allow for as precise information about the analyzed object as the mid-infrared, which enables much more accurate and faster temperature measurements or the analysis of volatile substance compositions.

Indeed, MIRPIC circuits present a significant technological challenge. However, we are fortunate to have secured the collaboration of a global authority in this field, Professor Ryszard Piramidowicz. Professor Piramidowicz has been collaborating with numerous companies and research centers worldwide for years and has unquestionable achievements in the field of photonic integration. The technological process we are developing together is already well mastered, although, for these circuits, which are dedicated to the mass market, we still face another stage of work—namely, the implementation of large-scale production. Currently, we are a company with a high degree of integration, which is our advantage and a permanent part of our strategy. However, when it comes to high-volume production, we may consider outsourcing certain stages to external contractors.

But when it comes to new features in consumer electronics enabled by the chips developed under the HyperPIC project, we're really only limited by our imagination! As the first example, I would mention all kinds of our health measurements, such as body acidity or blood parameters, conducted by personal portable devices. Systems based on near-infrared simply don't allow for reliable measurements; the use of systems operating in the mid-infrared range is essential. However, that's not the end. Currently, precise spectrophotometers operating in the MWIR range are large and expensive devices, making their integration a costly and challenging process. Miniaturization and mass production will significantly lower costs and allow them to be used, for example, in air conditioning systems that could acquire extremely accurate data about air quality. Such information could be critically important in hospitals or advanced industrial processes. You can also imagine a refrigerator that, thanks to spectrophotometry, could detect which product inside is no longer fit for consumption, and with the help of AI, automatically reorder it for your pantry.



Source: Vigo Photonics

UNIQUE TECHNOLOGIES OF VIGO PHOTONICS

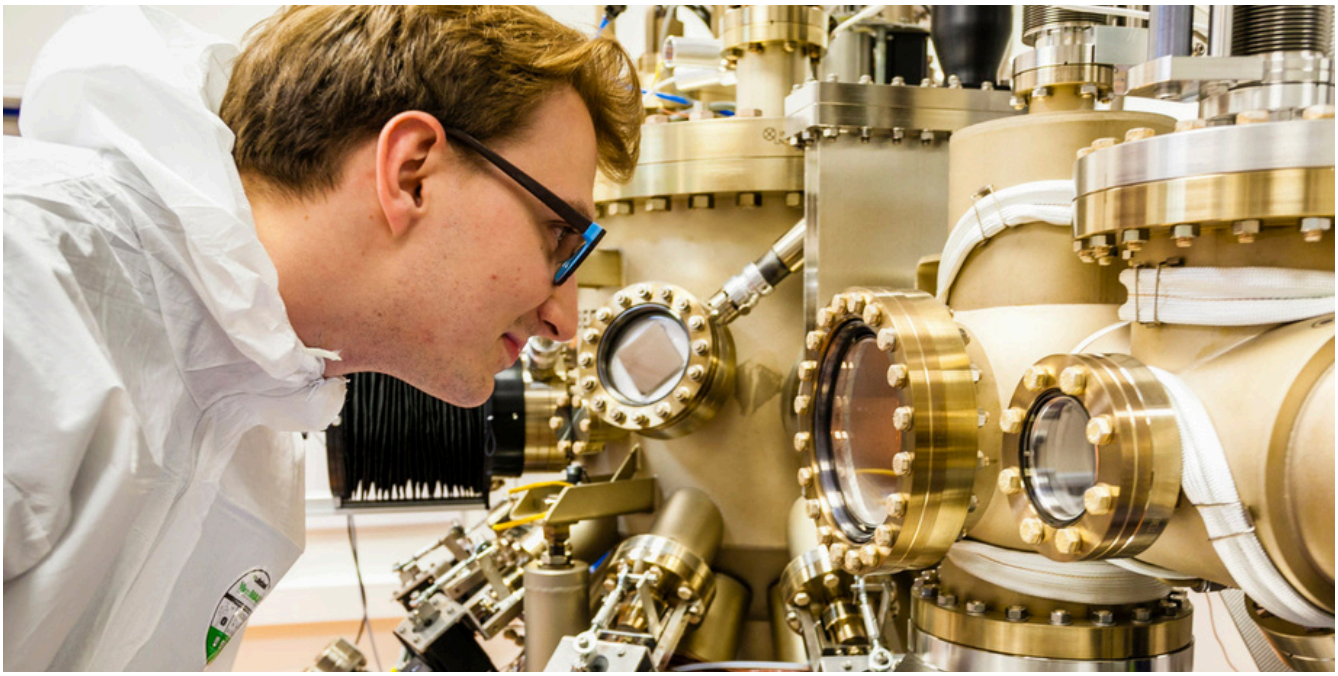
INTERVIEW WITH
EMIL BATOROWICZ
MARKETING MANAGER
AT **VIGO PHOTONICS**

At the moment VIGO Photonics team is composed of over 200 people. How, within Polish conditions, do you build a team focused on semiconductor production? Does higher education adequately prepare them for such work?

We do have some traditions and experience in Poland—up until the 1990s, there was the TEWA factory in Warsaw—but these are represented by the older generation. Moreover, semiconductor device manufacturing technology is very specialized, and we are the sole player in this part of Europe. Given these two factors, when we want to bring in new employees, we often have to train them ourselves to a large extent.

When we recruit a new employee, whether taken from another branch of the electronics industry or a recent graduate, we can't expect them to know exactly what to do right away. We assess candidates during their trial period, internships, or training, identify the roles that best suit their abilities, and then start their educating process. While part of their development involves external training and conferences, most of the knowledge is provided by our existing employees

In terms of collaboration with Polish universities, our primary contacts remain with the Military University of Technology and the Warsaw University of Technology. Regarding how well students are prepared for work in the semiconductor industry, there's definitely room for improvement under certain circumstance: : if universities were to undertake training aimed at this particular sector, it would require the creation of conditions for the development of the entire industry. As it stands, VIGO Photonics is almost alone in this field—we can't absorb all the graduates from specialized programs. A significant role here i salso supposed to be played out by the EU's strategy, directed at semiconductor production in Europe, and recent investments run in Poland by companies like Intel, which for sure encourages universities to educate human resources in this field.



Source: Vigo Photonics

SEMICONDUCTOR MANUFACTURING ECOSYSTEM IN POLAND

PPTF

An organization that unites and coordinates the efforts of the Polish microelectronics and photonics sector is the **Polska Platforma Technologiczna Fotoniki (PPTF)** [TN Polish Technology Platform for Photonics], established in 2013. The platform was created as a joint initiative of businesses, associations, universities, and research institutes operating in the field of photonics in Poland, aligning with the European Union's approach to the most innovative areas of the European economy. PPTF's mission is to enhance the innovativeness of the Polish photonics industry by coordinating the efforts of Polish entrepreneurs, scientific institutions, government, and local administration, as well as non-governmental organizations in the development of new technologies and optoelectronic products, workforce development, and the broader application of photonics technologies in Poland.

In 2023, PPTF and CEZAMAT initiated the establishment of the Klaster Mikroelektroniki, Elektroniki i Fotoniki (microEPC) [TN Microelectronics, Electronics, and Photonics Cluster]. The founding members of the cluster include 51 companies, universities, institutes, and organizations.

- I think that photonics is simply a technology with immense innovative potential, offering many promises for how we can genuinely make the world a bit better - said Maciej Nowakowski, who leads the work at PPTF, in an interview for Łukasiewicz – IMiF [1].

[1] https://imif.lukasiewicz.gov.pl/maciej-nowakowski/

BETWEEN SCIENCE AND **BUSINESS**

Łukasiewicz – IMiF

The IMiF [TN Institute of Microelectronics and Photonics] is part of the **Łukasiewicz** network, the third-largest research network in Europe, managing **440** R&D laboratories and employing nearly **4,500** research and engineering staff. Łukasiewicz – IMiF develops designs and manufacturing technologies for micro- and optoelectronic devices, including **microwave and photonic discrete devices, detectors, and sensors, integrated circuits, microsystems and electronic components, microelectronic hybrid circuits, power devices,** and **diffractive elements.** Moreover, the institute develops technologies for producing new materials such as **gallium nitride, epitaxial and flake graphene, ceramic-metal composites, glass,** and **advanced ceramics,** and studies their properties for industrial applications. The solutions from Łukasiewicz – IMiF are applied in various sectors, including energy, electronics, photonics, medicine, aerospace, defense, space, automotive, and other industries.

Łukasiewicz–IMiF conducts scientific research and development work in the following areas:

- **Photonic materials** – we conduct research works on developing new fiber optic structures, micro-optical elements, transparent ceramics, bioactive ceramics/glasses, and specialty glasses. Developed materials and structures are used in sensor and biomedical systems, microfluidic systems, fiber optic laser systems, beam delivery systems, telecommunications, and tissue regeneration using bioglass and bioceramics.
- **Functional materials** – we design and manufacture materials with new, unique properties using an interdisciplinary approach, advanced equipment (thin-film apparatus, 3D printing, SPS, HIP, Vacuum Sintering), and comprehensive material analysis (optical, electrical, thermal, photocatalytic, mechanical testing).
- **Graphene and composites** – we develop new materials and devices based on epitaxial graphene, flake graphene, silicon carbide, and gallium nitride, as well as nanostructures and composites. We conduct scientific and R&D projects funded by national and international sources and have access to cutting-edge technological and measurement equipment.
- **Materials and devices characterization** – we carry out research activities in the field of microelectronic materials and structures characterization. This includes supporting the development of new technologies, advancing research techniques, writing and participating in project proposals, authoring scientific publications, and promoting measurement capabilities.
- **Integrated circuits and system design** – ·we design dedicated integrated circuits (ASIC) and electronic systems for telemedicine, cybersecurity, and industry. We operate in a FABLESS system—accessing production technology through long-term institutional international collaborations and direct contacts. We have extensive experience in implementing national and international research projects—from FP5 to H2020.
- **Silicon technology and sensor systems** – we operate in the microtechnology field based on silicon technology, covering a wide range of topics: silicon photodiodes and ionizing radiation detectors, thermo-conductivity detectors, micromechanical sensors using mechanical resonance, microfluidic structures, microassembly techniques, and silicon mono-crystallization and processing.

- **GaN devices, sensors, thin-film structures, and porous materials** – we develop technology and design devices based on GaN and we operate in areas such as sensors, thin-film structures, and surface modification—(bio)sensors, thin-film structures, medical materials, surface modification for sensors intended for medical applications (e.g., screening, personalized medicine), environmental monitoring, and chemical analysis. We also cover the field of porous materials— porous materials for gas sensors and micro-energy storage systems based on supercapacitors, and we work on 3D structures such as diffractive optics.
- **Infrared photonics** – we carry out R&D works on global 'hot topics' within infrared photonics: cascade lasers and infrared detectors. We dispose of competencies and a full technological line that enables optoelectronic semiconductor device manufacturing —from device design and crystal structure growth to device fabrication and comprehensive characterization.
- **LTCC technology and printed electronics** – we conduct R&D works in the scope of LTCC technology and printed electronics, integration of electronic components and SMT assembly, circuit and sensor design for applications in medicine, environmental protection, photovoltaic installations, power systems, and electricity storage. The manufacturing and characterization of materials and ceramic and polymer composites for electronics applications also represent important aspects of our work.

Research works at Łukasiewicz – IMiF is based on four technological lines:

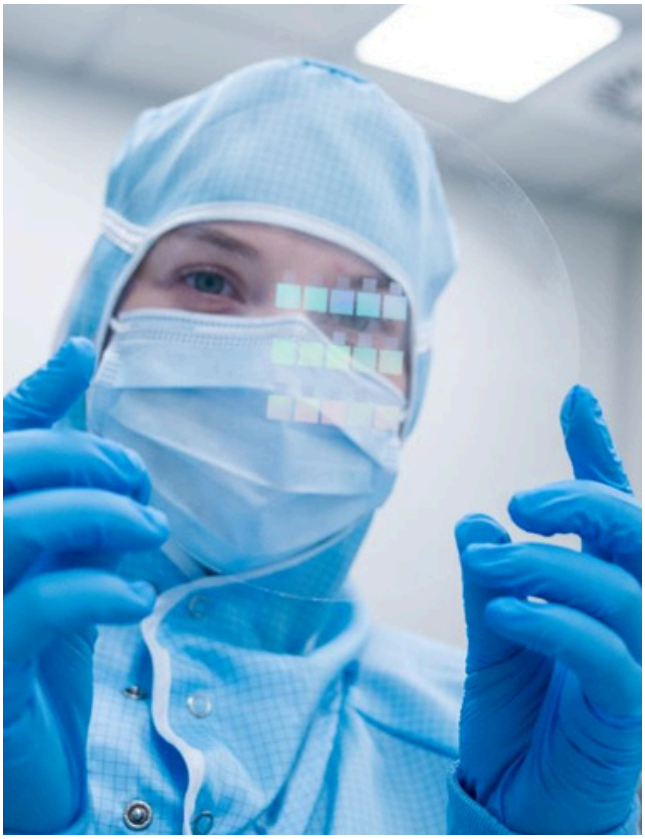
- **Optoelectronic component line**: photolithography, etching, deposition of metallic/dielectric layers, die bonding, wire bonding, and sealing structures in inert gas atmospheres.
- **Silicon component line:** process based on CMOS technology (with 3 µm design rules) and EBL (<1 µm), it includes RCA cleaning, photolithography, thermal processes, plasma and wet etching, metal deposition, ion implantation, micro-assembly operations, 1,200 m² cleanroom
- **Wide-bandgap semiconductor component line**: a complete technological line located in technology cleanrooms compliant with ISO-5 and ISO-6 standards, covering approximately 600 m², dedicated to manufacturing semiconductor devices based on gallium nitride (GaN) on various substrates (GaN, SiC, Si, sapphire), and performing processes for depositing various types of thin metallic, dielectric, and semiconductor layers
- **LTCC technology line**: the LTCC circuits are manufactured in a complexed technological process, starting from ceramic foil production, followed by processes such as foil cutting and hole formation, printing of conductive, resistive, and dielectric layers, module stacking and pressing, final thermal processing, assembly, and securing for final testing. This line allows for the production of three-dimensional electronic circuit structures based on pressed ceramic foils with printed functional layers.

BETWEEN SCIENCE AND **BUSINESS**

Łukasiewicz – IMiF implements projects and products dedicated to various industrial sectors: from electronics, automotive industry, cybersecurity, medicine, electromobility, and space industry to the defense industry. These include among others:

- quantum cascade lasers (QCLs) emitting light in the 4.5-5.5 μm and 8-10+ μm bands, compact and easily controllable. Perfect light sources for applications in the mid and far-infrared range
- microelectronic and photonic systems for targeting systems
- photodiodes for missile and rocket guidance systems
- AlGaN/GaN microwave transistor for S-band radiolocation with GaN-HEMT technology
- specialized integrated circuits for optoelectronic heads
- detectors for proximity sensors.
- cold plasma generator for protection against biological threats

The American Physical Society recognized as the most valuable two global achievements, in which members of the Institute's research team participated. One of these is the Rosetta probe mission, which landed on the surface of a comet. The other is the discovery of the element with atomic number 117.



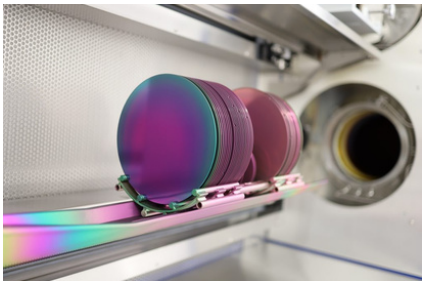
The production capabilities of Łukasiewicz – IMiF will be further strengthened in the coming years by the lines established through the creation of the Microelectronics and Photonics Competence Center, as part of the National Recovery Plan [TN Pol. KPO] and the Chip Joint Undertaking.

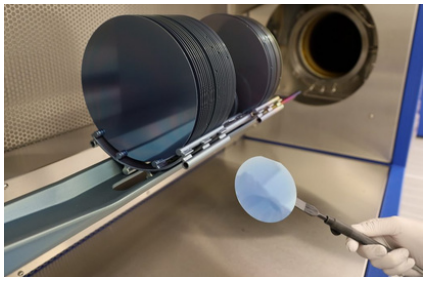
CEZAMAT

Centrum Zaawansowanych Materiałów i Technologii CEZAMAT [TN The Center for Advanced Materials and Technologies] at the Warsaw University of Technology is one of the largest research and development investments in high-tech fields in Poland. CEZAMAT PW is a complex of specialized laboratories where research is conducted on materials used in microelectronics, optoelectronics, nanoelectronics, and bioelectronics. In 2013, the European Union co-financed the investment with €76.6 million, with the total cost amounting to **€90 million.** The foundation stone for the current CEZAMAT headquarters was laid in September 2014. This is a collaborative project involving several Polish universities, with the **Warsaw University of Technology** playing a leading role. The consortium also includes the Institute of Physical Chemistry of the Polish Academy of Sciences, the Institute of Physics of the Polish Academy of Sciences, the Institute of High Pressure Physics of the Polish Academy of Sciences, the Institute of Fundamental Technological Research of the Polish Academy of Sciences, the Institute of Electron Technology, the Institute of Electronic Materials Technology, the University of Warsaw, and the Military University of Technology.

Currently, within CEZAMAT, there is a division dedicated to **Intelligent Semiconductor Systems**, which operates in five teams: Semiconductor and Planar Technology, Integrated Photonics, Optical Structure Technology, Internet of Things, and Micro Energy Generators.

- **The Semiconductor Technology Team** conducts research in the field of semiconductor materials, devices, and systems, not only based on silicon technology but also exploring alternative materials like GaN and SiC. The research focuses on CMOS devices, MOS/MIM tunnel diodes, and memory technologies. The team also works on nanostructure technologies for microelectronics and photonics devices. The technological processes carried out include surface preparation, thin film deposition, shape patterning, layer property modification, and etching.
- **The Integrated Photonics Team** runs development research in the scope of design, simulation, fabrication, and characterization of integrated photonic devices and systems. The team's achievements include integrated photonic elements operating in visible light, produced on material platforms such as silicon nitride, indium phosphide, and SOI. The Integrated Photonics Team specializes in devices used in biosensors, environmental sensors, and scientific applications. Their technological infrastructure allows for the independent production of oxide and nitride layers with precise thicknesses. The use of electron beam lithography in the manufacturing process enables the prototyping of photonic elements and systems without the need for photolithographic masks.
- **The Internet of Things Team** in collaboration with ST Microelectronics, has developed a distributed monitoring system: a self-organizing network of communicating sensors.
- **The Energy Microgenerators Team** focuses on developing new energy production techniques derived from waste sources (e.g., heat, vibrations, motion) or from distributed energy sources (e.g., light).



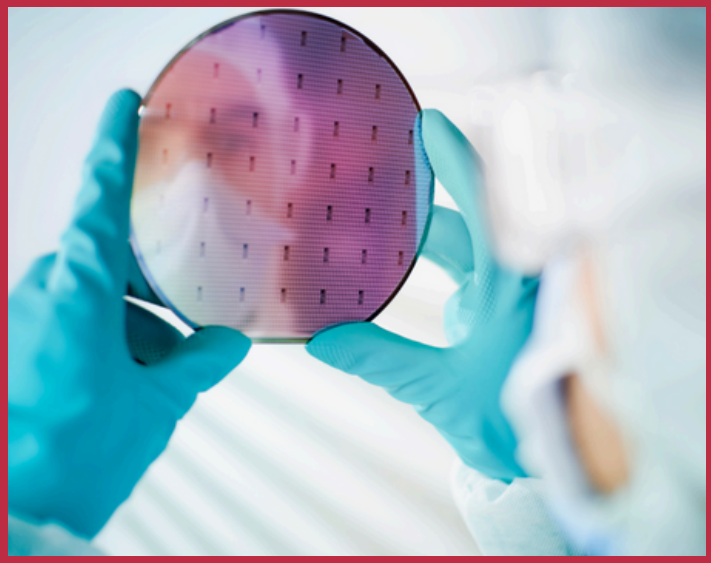


Source: Cezamat

BETWEEN SCIENCE AND **BUSINESS**

- **The Optical Structures Technology Team** takes care of precise optical components, manufactured using processes typical of semiconductor technology lines, including photolithography, electron beam lithography, layer deposition, and ion etching. The team has also developed technology for fabricating phase structures in grayscale electron beam lithography, enabling the exposure of variable height structures within a single process. Among the team's achievements are Fresnel lenses and kino-forms with thicknesses ranging from 0.5 to 3 μm and diameters in the millimeter range, reflective and transmissive holograms with submicron pixel dimensions, metastructures, diffraction gratings, and microlens arrays. Additionally, the team developed a method for creating transmissive X-ray diffraction structures on silicon nitride membranes, with dimensions below 50 nm.

*The Microelectronics and **Photonics Competence Center**, announced in May 2024, will be a joint venture of three scientific institutions, funded by KPO resources: **Łukasiewicz – Institute of Microelectronics and Photonics** (leader), **Łukasiewicz – Institute of Tele-** and **Radiotechnology,** and CEZAMAT PW. The project will have a total cost of **300 million PLN.***



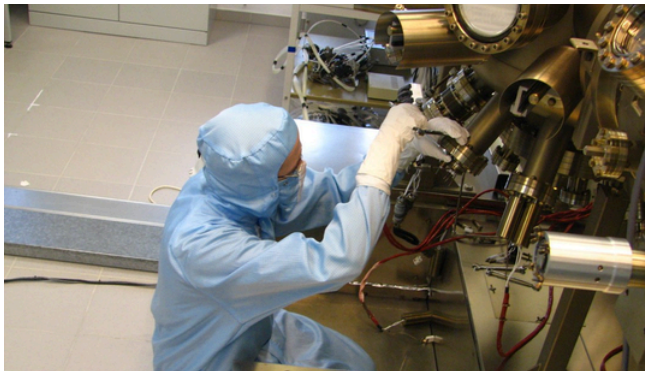
The Microelectronics and Photonics Competence Center project, which will be funded over the next two years by the Krajowego Programu Odbudowy (KPO) [TN National Recovery Program], represents a significant milestone for the participating institutions. This is not only due to the substantial funding of nearly 300 million PLN but also because it provides an opportunity for comprehensive modernization and the acquisition of new infrastructure, contributing to the development of a cutting-edge organization.
One of the key goals is to establish new laboratories that, by leveraging unique competencies in the design and production of both materials and devices, will enable a significant technological leap in Poland. From epitaxial layer growth technologies to the creation of innovative devices, the project will allow research to be conducted using the most advanced equipment. Additionally, modern measurement systems will enable even more comprehensive characterization of materials and structures at the nanoscale level.

BETWEEN SCIENCE AND **BUSINESS**

Unipress

The High Pressure Research Center of the Polish Academy of Sciences, also known as Unipress, is a leading research institute specializing in semiconductor physics, technology, and materials engineering. The institute is particularly renowned globally for its unique expertise in the **crystallization of bulk gallium nitride (GaN) crystals.** Research conducted at the institute covers a wide range of areas, including the physics and epitaxy of nitride semiconductors, biomaterial production, studies on soft matter and glasses, THz radiation physics, and other related fields. Unipress also develops and manufactures high-pressure equipment for research laboratories worldwide.

A part of Unipress is the **MBE Epitaxy Laboratory (NL-14), which specializes in the development of blue light-emitting diodes (LED) and laser diodes (LD)** produced using Plasma-Assisted Molecular Beam Epitaxy (PAMBE) technology. The team focuses on fabricating long-wavelength light emitters by theoretically modeling quantum structures and optimizing the optical and electrical parameters of devices manufactured on gallium nitride (GaN) substrates.



Production processes in the MBE Epitaxy Laboratory
Source: Unipress MBE

In April 2024, the Chips Joint Undertaking, operating under the European Chips Act, selected a team that includes UNIPRESS and Łukasiewicz – IMiF to implement one of four European pilot lines focused on advanced semiconductor technologies.

The WBG Pilot Line (Wide Band Gap semiconductors pilot line) aims to develop innovative material technologies and device fabrication methods based on wide band gap semiconductors, such as gallium nitride (GaN), silicon carbide (SiC), and gallium oxide (Ga203). These materials are crucial for industrial applications, automotive, renewable energy, consumer electronics, and defense. The project seeks to launch a pilot line and develop FD-SOI technology at 10 nm and 7 nm nodes. This technology, entirely developed within the European Union, is strategic for the advancement of semiconductor technologies in Europe.

As part of an international consortium comprising 22 research institutions and universities from Italy, Sweden, Finland, Austria, Germany, France, and Poland, the primary task for IWC PAN and Łukasiewicz – IMiF will be the development of techniques for growing GaN substrates and epitaxial layers, as well as advancing the technology for fabricating GaN and Ga203-based devices, including vertical power devices such as diodes and transistors. The construction of the pilot line is set to begin in early 2025, with Łukasiewicz – IMiF and IWC PAN receiving €50 million to achieve the project's goals.

Source: Łukasiewicz - IMiF

UNIQUE SOLUTIONS, DEDICATED SYSTEMS

INTERVIEW WITH
ANNA SZERLING
RESEARCH GROUP LEADER
AT **ŁUKASIEWICZ – IMIF**

Are the projects undertaken by Łukasiewicz – IMiF part of EU projects, or are they commissioned by private companies? Who are Łukasiewicz – IMiF's partners?

The sources of research projects carried out at Łukasiewicz – IMiF are quite diverse. These include tasks commissioned by commercial companies and directly funded by them, as well as research projects conducted under various European programs. However, it should be highlighted, that even in the second case, the consortium members or leaders of the projects are often commercial companies. Regarding the nature of the work, it is typically technological services/projects or the creation of prototypes or demonstrators.

Among the many partners of the GaN Devices, Sensors, Thin-Film Structures, and Porous Materials Research Group, I would like to mention the Institute of High Pressure Physics of the Polish Academy of Sciences (IWC PAN), which continues the work initiated many years ago by the company Ammono. IWC PAN collaborates with us on GaN transistor projects, where they supply GaN substrates. An example of recent collaborations with commercial entities includes our work on new LED sources, commissioned by the German company Crocus Labs GmbH, which develops solutions based on gallium nitride. We also cooperate with companies such as TEKNOMA Technological Materials Industrial and Trading Inc. from Turkey, the Polish company Dacpol, and Vigo Photonics. The Integrated Circuits and Systems Design Research Group also has extensive experience working with companies, focusing on silicon microelectronics design. Due to technological constraints, the group operates in a fabless model.

In Poland, we have over 30 OEM companies with a revenue scale exceeding 100 million PLN. Are there economic reasons for companies of this scale to be interested in semiconductor devices tailored to their applications, and could this become a driving force for their production in Poland?

It's not just about the budgets of Polish companies, but rather the general willingness to collaborate. By nature, engaging in a project aimed at developing entirely new solutions carries inherent risks. Many companies are not interested in pursuing projects that don't promise quick and certain profits. They prefer to stick to already established solutions, produced on a large scale and relatively inexpensive, even if the performance of such components is inferior to that of dedicated devices that could be developed through new technologies. However, this is changing more frequently due to various factors, such as increased competition and uncertainties related to military conflicts. Often, companies find that while a component might be available in a manufacturer's catalog, in practice, it's out of stock, available in limited quantities, or its specifications don't fully meet specific needs, making it difficult to work around these issues.

A unique, dedicated solution doesn't always have to mean the necessity of developing a holistic solution, but only of one singular component. A good example of this are Trumpf Huettinger and VIGO Photonics, which collaborate with us and utilize our technological services.

UNIQUE SOLUTIONS, DEDICATED SYSTEMS

INTERVIEW WITH
ANNA SZERLING
RESEARCH GROUP LEADER
AT **ŁUKASIEWICZ – IMIF**

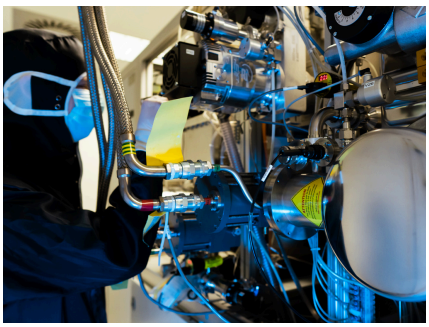
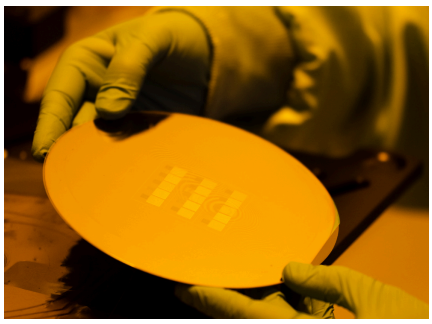
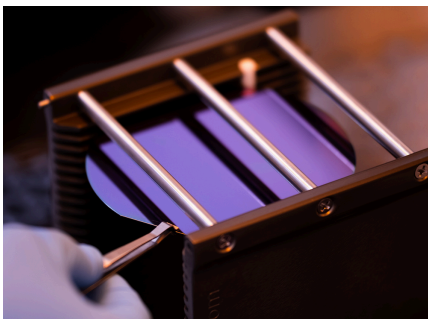
Is the Polish education system able to prepare the workforce for the emerging semiconductor manufacturing industry?

Universities are introducing classes related to semiconductors and technologies, with institutions like the universities of technology in Warsaw, Wrocław, and Łódź serving as examples. However, today's demands go beyond just lectures and exercises; it's essential to have training in technological laboratories where students can have sustained, hands-on experience with semiconductor device technology and prototyping. At Łukasiewicz – IMiF, in collaboration with universities, we are actively promoting the need for such programs and initiatives. We organize workshops, for example with Intel, and work together to develop training programs. The knowledge base in Poland is substantial, with many of us being members of international research teams, having worked abroad for many years, or participated in internships where we've gained insights into modern technological processes for developing semiconductor device prototypes.

In my view, we do not lag behind other countries in that manner. The main issue lies in the limited funding for maintaining technological laboratories that could train future employees for the microelectronics and photonics sectors.

On one hand, we recognize that the semiconductor industry investments currently underway in Poland and across Europe will draw talented individuals from the R&D sector into business. However, I believe our role is to educate the workforce for companies like Intel or Vigo Photonics. We must not, of course, neglect our core research and development activities, but we can simultaneously offer large companies the opportunity to train their workforce at market rates. We are well-equipped to do this, as besides the individual qualifications of our staff, we also possess full prototyping lines for semiconductor devices.

We are also working on establishing the Microelectronics and Photonics Competence Center, which will bring together semiconductor-related institutes from the Łukasiewicz Research Network and universities that aim to run programs preparing students for work in the semiconductor industry. The goal is to unite these entities to comprehensively conduct training cycles in microelectronics and photonics, preparing the workforce for this industry. The semiconductor manufacturing industry will require not only graduates from specialized study programs but also technicians. Unfortunately, due to the minimal vocational training at the technical school level in Poland, there are shortages in this area, which is why the Competence Center will also conduct training for technical staff.

Source: Łukasiewicz – IMiF

WORKFORCE
FOR THE SEMICONDUCTOR MANUFACTURING INDUSTRY

- In Arizona, we built a factory in the desert. Oregon didn't have a chip industry either. Wherever Intel goes, an entire ecosystem emerges. This requires cooperation between the private and government sectors. I'm also not worried about a lack of willing workers," said **Keyvan Esfarjani**, Vice President and General Manager of Global Operations and Head of Manufacturing, Supply Chain, and Operations at **Intel**, in February 2024. [1]

The fact that Poland currently lacks the necessary workforce is often cited as the primary obstacle to the development of the semiconductor industry in the country. Universities do not train professionals for this sector because there is no demand, and investors are hesitant to enter the market due to the lack of qualified personnel, creating a vicious cycle. However, Intel's investment and the optimism that followed its announcement are likely to break this cycle.

- We're expected to move to Poland to support and oversee the project. This will be a great experience to build the first semiconductor facility in Poland, while building a new organization to deliver this greenfield project. The employees will be a mix of local hires and expats from several locations, so we're expected to have a diverse, multinational team which will also contribute to the experience [2] - said **Nadav Bar-Ner**, Senior Director at **Intel**, responsible for building the factory in Poland, in March 2024. A similar path has been followed by other segments of the electronics industry in Poland, such as the EMS sector, where the first managers were expatriates who gradually trained local staff and passed on their knowledge. VIGO Photonics is adopting a similar approach: - *When recruiting a new employee, whether from other branches of the electronics industry or a recent graduate, we cannot count on them knowing what to do immediately. We assess candidates during their trial period, internships, or training, identify the roles that best suit their abilities, and then start their education process. While part of their development involves external training and conferences, most of the knowledge is provided by our existing employees* - says Emil Batorowicz. [3]

A very important voice, as emanating from a global perspective, also comes from Intel. This is the prospect of a great business, with unlimited opportunities and extensive experience: - *If we look at employees from other similar Intel facilities, we see experts from a wide range of fields. Since Intel's inception, we've recognized that the greatest innovation comes when we bring together people with diverse experiences—chemistry, physics, microelectronics—but also many specialties that might not seem directly related to semiconductors* - says **Maks Dropiński** from **Intel** in an interview with tek.info.pl and Invest in Pomerania.
The rapid advancements in front-end and back-end processes mean that what students learn today may be outdated in five years. It's only when we hire individuals with varied backgrounds and train them within our manufacturing processes that we create teams capable of developing future technologies. The focus is more on fundamental experience and mindset— it's not critically important for a specific field, like microelectronics, to be highly developed and to have a large number of male and female graduates who completed such studies. It's helpful but not essential.

[1] Source: https://www.pb.pl/intel-czeka-na-decyzje-brukseli-1208946
[2] Source: https://community.intel.com/t5/Blogs/Intel/We-Are-Intel/How-to-Build-a-Fab-Worth-4-6-Billion-Intel-s-New-Assembly-and/post/1583229
[3] Source: https://tek.info.pl/article/3865/vigo_photonics_od_pionierow_do_przyszlosci_fotonicznych_ukladow_scalonych
[4] https://tek.info.pl/article/3847/inwestycja_intel_pod_Wroclawiem_to_przelom_dla_ekosystemu_polprzewodnikow_w_polsce

WORKFORCE FOR THE SEMICONDUCTOR MANUFACTURING INDUSTRY

On January 31, 2024, Wrocław University of Science and Technology signed a letter of intent with Intel, which presupposes joint R&D projects, the development and adaptation of educational programs to better align with industry needs, and lectures to be conducted by Intel specialists – Among other, we plan to build a large, interdisciplinary research center specializing in micro and nanosystems. It will be equipped with unique apparatus, allowing us to conduct valuable research in this field and prepare our staff for collaboration with Intel - said Professor Arkadiusz Wójs, the Rector of Wrocław University of Science and Technology. The creation of this new center is expected to cost PLN 100 million [4].

The city of Wrocław also intends to contribute to the training process. In collaboration with Intel and the U.S. Consulate, a project called the Intel Institute has been under development since February 2024. This initiative aims to establish a branch of a university from the top 100 of the so-called Shanghai Ranking in Wrocław. The city has pledged to provide 2-3 hectares of land valued at PLN 100-200 **million for the project, where the university and associated R&D centers would be established.**

Gdańsk University of Technology, in line with its mission to foster innovation and bridge the academic environment with industry, has initiated collaboration with leading local semiconductor companies, including **Intel** and **Synopsys**. As part of this partnership, the university plans to equip state-of-the-art laboratories that will serve both educational and research purposes. The Department of Microelectronic Systems at the Faculty of Electronics, Telecommunications, and Informatics ETI PG has already received two powerful servers from Intel (each with 96 cores and 256GB of RAM). These servers have been installed in the departmental server room and will be used to support laboratories focused on integrated and programmable circuit design, with students accessing them remotely, reflecting current industry practices.

These initiatives also include internship and apprenticeship programs, providing students with practical experience in real industrial settings. Additionally, an essential aspect of this partnership is the consultation of the curriculum with industry experts and guest lectures by specialists from local companies, ensuring that the educational content is continuously aligned with the evolving demands of the job market. The synergy between Gdańsk University of Technology and the local ecosystem is expected to elevate the standard of technical education and significantly contribute to the development of the regional innovation ecosystem. Thanks to the cooperation between the Department of Microelectronic Systems and SEMI Europe offers students opportunities to enhance their semiconductor competencies through initiatives like the European Chips Skills Academy.

- Thanks to the direct involvement of semiconductor industry leaders, we can enrich our study programs with the latest technological advancements and provide our students with access to work with world-class companies. Partnerships with Intel, Cadence, and Synopsys enable us to educate future engineers at the highest level while also supporting the development of the regional innovation ecosystem - says DSc eng. Marek Wójcikowski, Prof. PG, Head of the Department of Microelectronic Systems, Faculty of ETI, Gdańsk University of Technology.

HUMAN RESOURCES FOR THE SEMICONDUCTOR MANUFACTURING INDUSTRY

STEM EDUCATION POTENTIAL IN POLAND

Gdańsk University of Technology
Faculty of Electronics, Telecommunications, and Informatics

Maritime University of Gdynia
Faculty of Electrical Engineering

Koszalin University of Technology
Faculty of Electronics and Computer Science

Poznań University of Technology
Faculty of Electronics and Telecommunications

Wrocław University of Technology
Faculty of Electronics, Photonics, and Microsystems
Faculty of Computer Science and Telecommunications
Faculty of Fundamental Problems of Technology

Kielce University of Technology
Faculty of Electrical Engineering, Automatics, and Computer Science

AGH University of Science and Technology
Faculty of Computer Science, Electronics, and Telecommunications

Kraków University of Technology
Faculty of Computer and Electric Science

Silesian University of Technology
Faculty of Electrical Engineering
Faculty of Automatic Control, Electronics, and Computer Science

Białystok University of Technology
Faculty of Electrical Engineering

Military University of Technology
Faculty of Electronics
Faculty of Optoelectronics

Warsaw University of Technology
Faculty of Electronics and Information Technology

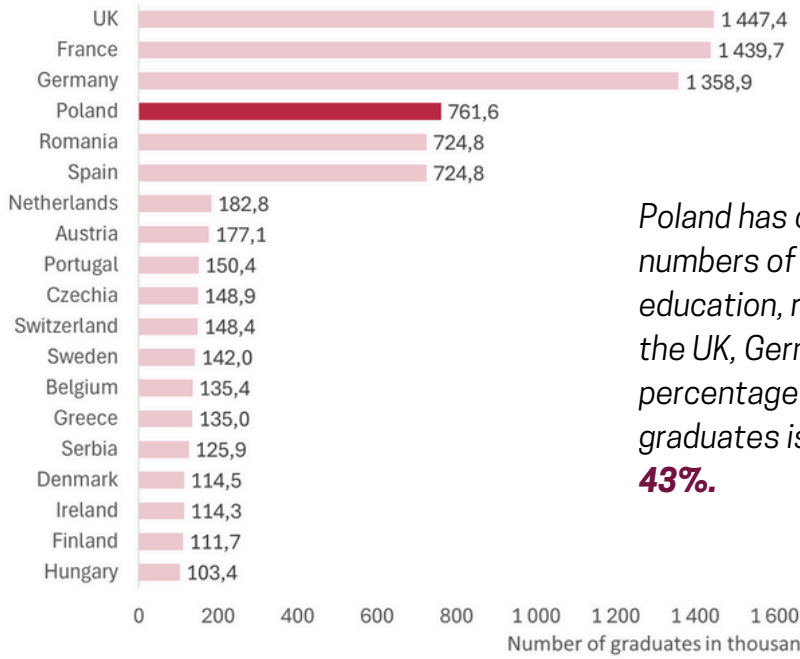
Bydgoszcz University of Science and Technology
Faculty of Telecommunications, Computer Science, and Electrical Engineering

Lodz University of Technology
Faculty of Electrical, Electronic, Computer, and Control Engineering

Lublin University of Technology
Faculty of Electrical Engineering and Computer Science

Rzeszów University of Technology
Faculty of Electrical and Computer Engineering

NUMBER OF **STEM** GRADUATES FROM **2013** TO **2019**



Source: Eurostat

*Poland has one of the largest numbers of people with technical education, ranking **4th** in Europe, after the UK, Germany and France. The percentage of women among STEM graduates is the highest in Europe at **43%.***

SWOT ANALYSIS

OPPORTUNITIES

- The European Chips Act stimulates semiconductor industry growth across Europe
- The COVID-19 pandemic has triggered a noticeable trend of shifting production closer to Europe (nearshoring)
- Positive experience of foreign investors in other electronic market segments
- High level of International connections in the supply chain
- Geographical proximity of European semiconductor supply chain factories
- Established of relations with Taiwanese partners: SEMI, TeaLa, TAIROA, and Taiwania Capital
- Organization of SEMI - ISS Europe in Sopot in 2025 and 2026, and appearance of Poland at SEMICON TAIWAN in 2023 and 2024

THREATS

- Competition from Western European countries
- Other Central and Eastern European countries increasing role on the international stage
- Dominance of certain countries at specific stages of the supply chain, hindering the development of other countries
- Low recognition of Poland and our potential as an investment location among global semiconductor companies (e.g. in Taiwan)
- Investors' fears of war with Russia

STRENGTHS

- Presence of several companies from the semiconductor production supply chain, including a key investor, Intel
- Well-developed other segments of the electronics market: OEM and EMS
- Well-developed sectors supporting semiconductor development: military, production automation, software
- Strong chemical sector with initial experience in semiconductor chemicals production
- Intel's decision to build an OSAT facility near Wrocław
- Good level of higher education and academic faculty
- Developed system of incentives for investors from the government
- A supplier market integrated around Semicon Supply Poland

WEAKNESSES

- Small number of higher education programs including elements preparing students for work in the semiconductor industry
- Limited financial resources of Polish companies compared to the capital needs of the semiconductor industry
- Small number of skilled workforce ready to work in semiconductor production
- Lack of a well-developed supply ecosystem for semiconductors in Poland
- Low participation of Polish companies in the global semiconductor supply chain

PAIH SUPPORT FOR ENTREPRENEURS IN THE SEMICONDUCTOR SECTOR

Poland offers a wide range of incentives for the semiconductor sector to attract investments in this area and build a supply chain that will contribute to achieving the goals set by the European Union related to reducing reliance on chip imports from third countries. Entrepreneurs in this sector can benefit from both the substantive support of the Polish Investment and Trade Agency S.A. (PAIH) and financial incentives, such as regional investment aid. Additionally, a special program has been created for them in response to the European Chips Act - the National Framework for Supporting Strategic Semiconductor Investments (National Framework).

Departament Wsparcia Inwestycji (DWI) [TN The Investment Support Department] PAIH offers comprehensive support to investors considering locating or expanding their operations in Poland, and each time takes an individual approach to entrepreneurs and their investment plans. The services provided by DWI PAIH include location advisory, organizing site visits, providing information on investment incentives, preparing information packages, identifying potential business partners, collaborating with startups and technology providers, organizing business meetings, assisting in building relationships with research institutes and innovation centers, support in dealings with government authorities, and post-investment care. DWI PAIH also manages a database of investment sites known as the Investment Offer Generator. All PAIH services are offered to entrepreneurs free of charge.

PAIH
Grupa PFR

*As of the end of March **2024**, the DWI PAIH handles **138** investment projects (51 service-oriented and 87 production-oriented). In terms of declared investment value (CAPEX), dominant are investments in the production sector **(nearly EUR 10 billion and 35,000 new jobs).***

PAIH SUPPORT FOR ENTREPRENEURS IN THE SEMICONDUCTOR SECTOR

EUROPEAN CHIPS ACT

The European Chips Act aims to support investments in semiconductor production, the development of advanced technologies, and the promotion of research and innovation in this field. This act is designed to help European companies gain a competitive position in the global market.
Poland's response to the above was the enactment of the **National Framework** under which a semiconductor sector entrepreneur can obtain support for a project aimed at establishing an integrated production facility or an open EU factory, as defined by the European Chips Act. The maximum allowable support for a project is determined based on the identified funding gap relative to the project's costs. The investor must commit to an **investment input** of at least **850 million PLN** during the project implementation period, which must not exceed **20 years,** and to creating at least **100 new jobs**, and maintaining them until the project's end.
PAIH is an institution that provides information about this form of public assistance, supports investors in the process of assessing project eligibility, and helps prepare the application documentation. In parallel with the National Frameworks, Poland is working on further implementing the European Chips Act. According to the European Chips Act, Poland will designate a contact point to serve as a liaison to ensure cross-border cooperation with other member states.

GOVERNMENT **GRANT**

Investors looking to undertake new semiconductor projects in Poland can apply for a government grant under the regional aid package. PAIH consults with businesses on preparing their applications and supporting documents. During these consultations, PAIH specialists provide support and guidance on the application process. An investor is assigned a project manager who leads and coordinates the project, maintains ongoing contact with the investor, and supports them at every stage of the project.

SUPPORT **TYPES**

Within the Program, support will be provided under two categories:

1. Eligible investment costs **(CAPEX)**
2. Eligible costs for **creating new jobs**

Entrepreneurs can receive support for projects classified as "initial investment" according to Commission Regulation (EU) No 651/2014 of 17 June 2014, which declares certain categories of aid compatible with the internal market under Articles 107 and 108 of the Treaty. In the case of large enterprises undertaking investments in the regions of Lower Silesia, Greater Poland, and parts of Masovia (Warsaw agglomeration), they can receive support for projects classified as an "initial investment starting new economic activity" according to the aforementioned Regulation.

PAIH SUPPORT FOR ENTREPRENEURS IN THE SEMICONDUCTOR SECTOR

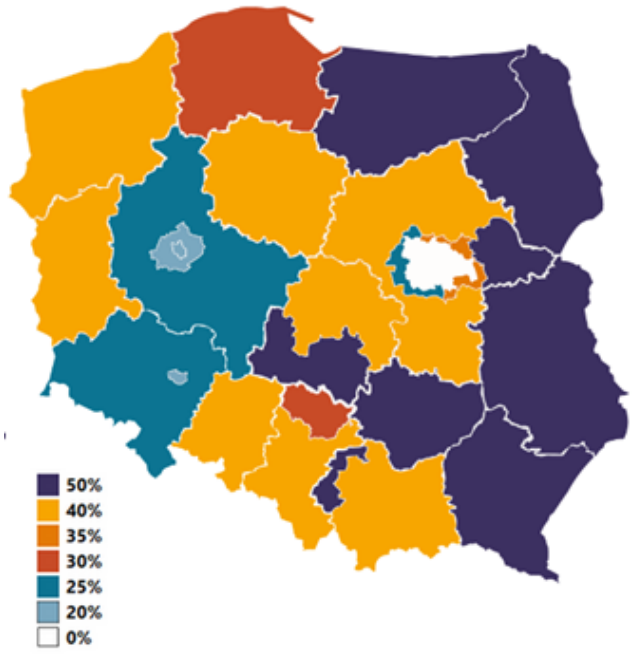
SUPPORT **FORM**

Support is granted in the form of a subsidy based on a bilateral agreement between the Minister responsible for economic affairs and the investor.

LEVELS OF **REGIONAL STATE AID** IN POLAND - HOW MUCH CAN BE RECEIVED?

Poland has adopted a new regional aid map that specifies the percentage limits of support for **large companies** in different regions of the country (from **20%** up to **50%**). **Medium-sized and small companies** can benefit from an additional increase in regional aid intensity by **10** and **20** percentage points, respectively. On the other hand, for large investments exceeding **55 million euros**, the maximum state aid is adjusted—calculated based on the "adjusted aid amount" formula as defined in Regulation 651/2014.

REGIONAL AID INTENSITY MAP



Obligation to Collaborate with Higher Education and Research Institutions

As part of the government grant support, a large enterprise is required to incur costs during the implementation or maintenance of the investment, specifically for collaboration with higher education and research institutions or secondary schools, amounting to at least 15% of the value of the granted support.

Requirement to meet quality criteria according to the Program

When applying for a government grant, an investor must not only meet quantitative criteria but also declare compliance with quality criteria, most of which are verified during the maintenance period. In the qualitative assessment of the investment, a company can earn up to 10 points. The minimum number of points required depends on the project's location and ranges from at least 4, 5, or 6 points, depending on the location.

Increased support for employee training

The amount of support related to the costs of creating new jobs or investment costs can be increased if the company offers training to its employees.

INVESTMENT COST SUPPORT (INVESTMENT GRANT)

To apply for investment cost support entitles implementation of the following investments:
1. Strategic,
2. Innovative,
3. R&D Service center,

compliant with the criteria outlined in the below table

Minimum quantitative criteria table — investment expenditures and employment for investment projects undertaken by large enterprises applying for an investment grant

Investment type	Minimum investment xxpenditures (million PLN) [1]	Minimum employment [1]	Maximum support (as a % of eligible costs) [2]
Strategic	160	50	-micro-entrepreneur / small entrepreneur: **25% / 15%** - medium-sized entrepreneur / scaling entrepreneur: **20% / 10%** -large entrepreneur: **15% / 5%**
Innovative	7	20	
R&D Service center	1	10	up to **25% / 15%**

[1] The minimum investment expenditures and employment refer to large enterprises and are proportionally lower for micro, small, medium-sized, and scaling entrepreneurs, or if the investment is located in an area at risk of exclusion; minimum employment requirements are reduced in the case of reinvestment.
[2] Depending on the location of the investment and the number of new jobs created.

SUPPORT FOR **JOB CREATION COSTS** (EMPLOYMENT GRANT)

To apply for investment cost support entitles implementation of the following investments:

- Business Service Centers,
- R&D Service Centers,

compliant with the criteria outlined in the below table

Table of minimum quantitative criteria - investment expenditures and employment for service projects applying for an employment grant

Investment type	Minimum investment expenditures (million PLN) [1]	Minimum employment [1]	Maximum support (per job, in PLN) [2]	Process type
Business Service Centers	1	100	15.0 K / 7.5 K	Intermediate, advanced, and highly advanced services (as specified in Annex 2 of the Program)
R&D Service Centers	1	10	up to 40 K / up to 30 K / up to 20 K / up to 15 K	Research and development services (as specified in Annex 2 of the Program)

[1] The minimum investment expenditures and employment requirements refer to large enterprises and are proportionally lower for micro, small, medium-sized, and scaling entrepreneurs, or when the investment is located in an area at risk of exclusion.
[2] Depending on the location of the investment and the number of new jobs created.

PAIH SUPPORT FOR ENTREPRENEURS IN THE SEMICONDUCTOR SECTOR

SUPPORT GRANT **PROCEDURE**

The application process for a government grant is regulated by the Program. To obtain the grant, the entrepreneur must submit the following documentation:

To **PAIH:**

- A completed application form in Polish (Project Information),
- The incentive effect analysis (concerns large and developing entrepreneurs),
- Attachments specified in the Project Information,
- A copy of the application submitted to the relevant Minister of Economy.

To the **relevant Minister of the economy:**

- A public aid application form with necessary attachments.

Work on the investment can only begin after submitting the application for public aid, including attachments, to the relevant Ministry of Economy (an analysis of the incentive effect is required only for projects carried out by large and developing enterprises), as described above.

The government grant is one of the more popular forms of support. The key to successfully completing the application process is to properly structure the project and accurately prepare the documentation.

INCOME TAX EXEMPTION

It is currently possible to benefit from income tax exemption across all of Poland, where regional aid is available. The period for which the support decision is issued depends on the intensity of public aid for the location of the investment and can be 12, 14, or 15 years. The decision is issued on behalf of the Minister responsible for the economy (currently the Minister of Development and Technology) by the Special Economic Zone managing the area in question.

TAX RELIEF

Tax reliefs for entrepreneurs are special entitlements that allow for the reduction of the amount of taxes that businesses would otherwise have to pay. These reliefs enable companies to save funds, which increases profitability and the ability to invest in the company's growth.

- **R&D relief** stands for incentive supporting entrepreneurs engaged in R&D activities. It allows the deduction of eligible costs associated with R&D activities from the taxable income base for business revenue (PIT) or other than capital gains income (CIT). Thanks to this relief, costs incurred for R&D can be counted twice when calculating the due income tax.
- **Innovative employee relief** complements the R&D relief. If the eligible costs for R&D activities exceed the entrepreneur's income for a given tax year, the entrepreneur can reduce the PIT tax advance payments, which should be paid on salaries paid to innovative employees, by the amount of those costs.
- **Robotization relief** allows entrepreneurs to make an additional deduction from the tax base for income tax purposes up to a maximum of 50% of the costs associated with investments in robotization.
- **Prototype relief provides** supports investors at the pre-mass production stage, enabling them to deduct from the tax base the costs of trial production of a new product and the costs of bringing a new product to market.

REGIONAL SUPPORT **INVEST IN POMERANIA** FOR INVESTORS

Invest in Pomerania is a regional initiative coordinated by the Agencję Rozwoju Pomorza [TN Pomerania Development Agency], primarily aimed at supporting foreign investors in the investment process and enhancing the investment attractiveness of the Pomeranian Voivodeship. The organization serves as a central point of contact, providing support at every stage of the investment process.

Invest in Pomerania

BEFORE INVESTMENT

- ***Data analysis:*** *We provide comprehensive information on the region's economy, key industries, real estate market, human resources, and legal regulations.*
- ***Investment offer:*** *We develop a complete investment offer tailored to the project's needs, considering factors such as employee availability, employment costs, rental and sales prices for office and warehouse spaces, and investment land, as well as the number of potential contractors.*
- ***Investment support:*** *We provide complete information on the currently available forms of investment support.*
- ***Networking:*** *We assist in establishing contacts with local authorities and potential business partners.*
- ***Visit organization:*** *We plan and organize local visits, including reference visits with strategic HR and real estate agencies, as well as visits to investment sites.*

DURING INVESTMENT

- ***Administrative support:*** *We offer investor advocacy support in obtaining necessary permits and conducting other administrative tasks. We ensure full support in all administrative matters, including residence and work permits.*
- ***Temporary office space:*** *We provide temporary office space for the incubation period of the investment.*
- ***Employer branding promotion:*** *We promote the investment project from an employer branding perspective.*
- ***Business development:*** *We introduce investors to the local business community and organize joint marketing activities at conferences.*

POST-INVESTMENT CARE

What sets us apart is our extensive range of post-investment support. We offer comprehensive investment care, including investor advocacy services, such as:

- ***Media communication:*** *We announce the investment in the media through press releases or media events.*
- ***Talent attraction:*** *We assist in attracting talented employees.*
- ***Employer branding campaigns:*** *We create personalized campaigns under the "Live more. Pomerania" initiative to position the company as an attractive employer.*
- ***Integration with the local community:*** *We help investors integrate with the local business community.*
- ***Reports and analysis:*** *We create analytical reports in the "Focus On" series about the most innovative sectors of the Pomeranian economy.*

REGIONAL SUPPORT FOR SEMICONDUCTOR SECTOR INVESTORS

The revitalization of the semiconductor sector in Poland is also supported by efforts to promote Poland on the international stage. Leading these efforts is the Invest in Pomerania initiative, the first regional member in Poland of the international association SEMI, which brings together over 3,500 companies from the semiconductor sector.

- In 2021, we initiated cooperation with the World Bank, which conducted an analysis of the investment potential of the Pomeranian Voivodeship. The analysis indicated that our region is a very suitable location for investments in the semiconductor industry. The report is available at www.investinpomerania.pl. This was a time when active investment movements began across Europe due to disruptions in supply chains and China's dominance in this sector. In June 2023, we joined SEMI, a key global semiconductor organization, and engaged in strategic discussions about the sector's development in European countries. A few months later, the Chips Act came into effect. It was the perfect moment to raise awareness among potential investors - says Monika Wójcik, Industrial Sectors Promotion Manager at Invest in Pomerania.

In 2023, Invest in Pomerania focused on promoting Poland and the region during SEMICON Europa, SEMICON West in San Francisco, and SEMICON Taiwan. In the same year, the platform semiconductors.investinpomerania.pl was launched, which provides key information about Pomerania's investment offerings and industry articles.

Starting from **2025**, at the initiative of Invest in Pomerania, the Tri-City will host a key strategic event in Europe - **Industry Strategy Symposium** organized by **SEMI.**
- A semiconductor event of this scale will be held in Poland for the first time. It will attract hundreds of leaders from the sector to the Tri-City. We will use this opportunity to broadly promote our location. So far, cities like Berlin and Vienna have hosted this event. This time, we will bring investors to Pomerania and use this time to showcase the potential of our country - adds Monika Wójcik.

In 2024, Invest in Pomerania will also organize the Pomeranian exhibition booth during the SEMICON Europe trade fair, which will be held in conjunction with the Electronica fair

AUTHORS

The report was prepared by the team at **tek.info.pl**, a portal dedicated to professionals involved in electronics design and manufacturing.

We invite you to the regular TEK.day electronics industry meeting on **September 26, 2024,** in Gdańsk. During the event, the report's content will be presented by its sponsors.

The achievements of the Polish semiconductor sector will be showcased at the Semicon Taiwan trade fair at the national booth from **September 4-6, 2024.**

Promotion of Poland and Pomerania will take place during the Semicon Europa trade fair at the Pomeranian regional stand, **November 12-15, 2024.**

The annual international meeting of semiconductor sector leaders in Sopot, organized by SEMI under the patronage of Invest in Pomerania, will be held from **March 12-14, 2025.**