CATHARINA DAUM

From chips to solar cells: four plasma makers are tinkering with the future

Chips, cell phones, photovoltaic systems – countless products around the world depend on plasma for their manufacture. But only a few highly specialized companies develop generators that can initialize this plasma and keep it perfectly under control. One of these companies is TRUMPF's Electronics division, based in Freiburg and Zielonka near Warsaw. Four plasma specialists discuss who uses the generators and the future technologies for which they are crucial.

There's a purple glow in the steel containers. Wojciech Gajewski stands in the shimmering light by a tangle of cables leading to laptops and generators. The Doctor of Physics has been working at TRUMPF in the Warsaw metropolitan region for almost ten years. "Today, there are very few industries that can do without plasma. We need it to manufacture tools for hardware stores and optical lenses for cameras. Plasma is used to treat the surfaces of architectural glass, television and cell phone displays," says Gajewski. He and his research team analyze the processes in the plasma chambers down to the last particle, and are constantly tinkering around with the plasma generators to further refine them. Gajewski now pulls out a pen and paper and uses sketches to explain exactly what happens in a plasma chamber. "Essentially, there are two processes: you either apply a layer or you remove a layer. In both cases, plasma is the method of choice. For this, we use a noble gas such as argon, which is inexpensive and easy to procure. By supplying energy with the help of our generators, we create the plasma. This can then be used to coat all kinds of things. If we use a lot of energy, we can introduce structures into the material or even drill holes. Experts refer to this process as plasma etching," says Gajewski.

A world without plasma? Sad!

Wojciech Gajewski, PhD in physics and specialist for vacuum processes at TRUMPF in Zielonka

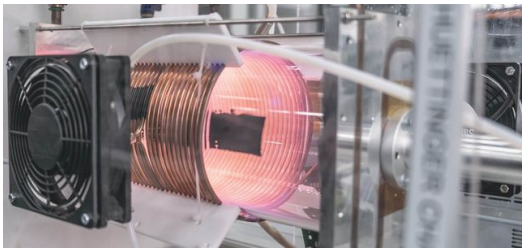
SCRATCH-RESISTANT SMARTPHONES

Gajewski sees himself as the interface between the TRUMPF development team and the "plasma process guys" on the

customer side. The aim is to integrate the plasma generator into their process on a "plug-and-play" basis wherever possible: "The focus is on what the customer wants to accomplish. We show them what results they can achieve if they choose the right settings," says Gajewski as he walks through his laboratory with its numerous plasma chambers. This is where his team simulates applications from the high-tech factories of this world. At the end of each experiment is a kind of instruction manual: for scratch-resistant smartphone displays, innovative coatings for solar cells and particularly fine structures on semiconductors.

An employee in the plasma laboratory analyzes the processes inside the chambers.

Special generators for every application: Generators for the semiconductor industry are created from numerous components some of which are manufactured automatically.



The chambers in the TRUMPF laboratories initialize plasma for various applications. The color of the glow depends on the gas used.

THE POWER TAMERS OF THE CHIP INDUSTRY

In addition to Dutch company ASML, TRUMPF supplies other leading players in the semiconductor industry with plasma generators, which are vital for the production of state-of-the-art memory and AI chips. Electrical engineer Agata Dul knows the needs of the industry inside out. Together with her team, she devises the most sophisticated power formula for the best plasma. Because the better the plasma, the more circuit traces can be placed on a chip and the higher its performance. And generators from TRUMPF are the key to this. "In the solar sector, we have to be particularly fast. In medical applications, quality plays the biggest role. And in the semiconductor market, we have to be both: fast – and perfect," says Dul. Industrially generated plasma creates a production environment that can be meticulously controlled and allows the most delicate structures to be fabricated. Perfect for transforming a silicon wafer into several multi-layered chips. "The plasma generators that we are currently producing here are among the most modern in the world," Dul explains. TRUMPF's generators can ramp the extremely high voltage up and down again as many as 400,000 times a second. "These short, powerful pulses allow finer structures to be reproduced on the semiconductors. We're talking about the low nanometer range here," she explains. One nanometer corresponds to one billionth of a meter. By way of comparison: a human hair has a diameter of approx. 80,000 nanometers.

We have to work quickly and deliver a perfect product.

Agata Dul, Engineer and responsible for the product line of high-voltage generators at TRUMPF in Zielonka

MORE POWER FROM THE SUN

More than half of all solar modules worldwide are already produced with the aid of high-tech solutions from TRUMPF's Electronics division. "Generators are at the heart of every photovoltaic production process. With their help, manufacturers apply layer after layer to a silicon wafer to create a solar cell piece by piece. Our generators constantly supply the exact amount of energy required to produce the plasma for this process," explains Jakub Studniarek, Head of Product Line Bipolar in the TRUMPF Electronics division. Now, the plasma generators can be used to achieve a leap in efficiency. This should mean that solar modules will soon play an even greater role in the electricity mix. "We are currently working on what is known as "TOPCon" technology, which allows manufacturers to increase the efficiency of their cells. This is because the technology delivers good results even in bad weather," explains Studniarek. A TOPCon cell owes its power to a specially developed plasma chamber, which is what made a particularly thin layer possible on an industrial scale in the first place. "Previously, the technology to generate the right mix of current intensity, power and voltage was simply not available for series production. We were involved right from the start with our plasma generators and rose to the challenge. We are one of the few specialists who have mastered this process down to the last detail," says Studniarek

The better the plasma, the more power the solar cell delivers.

Jakub Studniarek, Head of Product Line Bipolar at TRUMPF in Zielonka

GREEN SMELTING FURNACES FOR INDUSTRY

From solar roof to the production floor: when cement, steel or glass is being processed, gas and oil burners generate blistering heat. The source of that heat is fossil fuels – something that Gerd Hintz is determined to change by converting industrial facilities from fossil fuels to electricity. However, electrification in industry is not as straightforward as it is in the domestic sphere. At temperatures of more than 1,000 degrees Celsius, power and robustness are crucial. Together with the development team of TRUMPF electronics, Gerd Hintz has therefore been working on the development of climate-friendly process power supplies. The result: a solution with thermal plasma torches that can excite generators with special frequencies depending on requirements, thereby replacing fossil-based heating processes. Today, together with the application engineers, Gerd Hintz explains to potential pilot customers the plasma torch technology that best suits their needs, the frequency they require and how quickly the costs could be amortized. The trend continues to gather pace. If Gerd Hintz has his way, the source of process heat in energy-intensive industries will be different in 2030: green electricity that generates an electric "mega" flame.

The source of process heat in energy-intensive industries will be different in 2030.

Gerd Hintz, Industry Manager Industrial Heating at TRUMPF in Freiburg

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