PHOTODETECTORS WITH A GRAPHENE HEART

Polish researchers from technical universities in Warsaw and Łódź are working on a range of next-generation, ultrafast, infrared detectors based on graphene, the new wonder material. The new detectors will primarily be used in military and space technology. To develop them, the researchers have teamed up with engineers from the Vigo System company from Ożarów Mazowiecki near Warsaw.

The researchers want their near- and far-infrared photodetectors, which will work beyond the visible light spectrum, to have parameters far surpassing those offered by conventional technologies available on the market. The new devices will be unprecedentedly fast as a result of using graphene.

"Graphene is the heart of the whole system and the active part responsible for speed—the key parameter of the detector," says Mariusz Zdrojek from the Faculty of Physics at the Warsaw University of Technology, who heads the Ultrafast Graphene Photodetectors project.

Graphene is an excellent conductor of electricity, which will allow the new device to work faster than conventional detectors, the researchers say.

The photodetectors on which the scientists are working will detect infrared radiation that the human eye cannot see. Standard detectors of infrared radiation are currently used, for example, in photocells, cellular phones, and night vision devices. The use of the new class of detectors based on graphene will make it possible to develop innovative applications. But this depends on the final results of the project, the researchers say.

The new detectors can be used in lidar-type systems, the equivalent of standard radar but involving the use of laser, says Zdrojek. The term lidar is a portmanteau of "light" and "radar" and stands for a remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. Lidar is used to make high-resolution maps, with applications in geomatics, archeology, geography, geology and physics.

Graphene will also make it possible to build a system to track fast-moving objects—the civilian, commercial equivalent of missile tracking systems in the military, Zdrojek adds.

Also important are research applications in specialized scientific apparatus for calibrating various kinds of equipment operating on the basis of high-speed lasers, according to Zdrojek.

Another potential application is the transmission of data over long distances—between two continents, for example. This is a difficult topic in telecommunications, because a special signal is needed.

"The devices we are working on could help transmit data over long distances," says Zdrojek. This is still a distant goal because the project has only just begun. But there is a solid base available in the form of graphene production technology developed by Polish scientists. In their work, the researchers are using graphene obtained from the Warsaw-based Institute of Electronic Materials Technology, which has developed a graphene production method and is a leading center for graphene research internationally. However, the parameters of this material still need to be upgraded, the researchers say.

The Ultrafast Graphene Photodetectors project is funded mainly by the National Center for Research and

Development (NCBiR) under its Graf-Tech program. The researchers have received almost zl.5 million from this source. One of the conditions for granting the money was that they had to enlist an industrial partner.

The project attracted the Vigo System company from Ożarów Mazowiecki near Warsaw, which had no prior interest in graphene, but has been manufacturing infrared detectors for years. The company's detectors are sold throughout the world and are even sent into space.

"We were knowledgeable on graphene, and they were experts on detectors. The combination of the two resulted in this particular project," says Zdrojek.

The initial stages of the project consisted of developing the concept for the device, which was handled by the Warsaw University of Technology in consultation with Vigo System. In turn, the Łódź University of Technology handled the technology tasks—building part of the device according to specific guidelines.

The project is expected to result in a prototype and a parameter demonstrator, the researchers say. Only then will the consortium decide where such a detector can be used and how it should be upgraded in order to increase the number of its applications. Vigo System experts say there is a market for such devices. Just how big this market is depends on the final parameters of the photodetectors.

Why do scientists need industrial partners to carry out such projects? According to Mirosław Grudzień, CEO of Vigo System, innovation is the ability to convert knowledge into money. Poland has long had people with knowledge, and also people with the skills to sell products on the market, but these two areas were worlds apart. Knowledge was concentrated in research and development institutions, while the ability to sell a product and marketing expertise was the realm of industry. "The only reasonable solution is to set up research centers in industry to conduct research resulting from the need to create innovative and competitive products," says Grudzień. In his opinion, research and development work conducted by academic institutions is the least effective and most expensive option. "Not because the employees of these institutions are less competent, but because they do their research in between a lecture at the university and teaching a class; in between a grant application and writing a conference report. They have only 30 percent of the time for research that employees who are fully focused on this have," Grudzień says.

"When setting up the [Vigo System] company, I decided that I would go global with my product and create conditions in the company for prominent Polish scientists to work," Grudzień adds. "And such people work in my company today. This means that my response to the needs of the market is practically instantaneous. Research projects being conducted in my company take three months to complete, while at a university that would take three years."

"The only reasonable solution is to set up research centers in industry to conduct research resulting from the need to create innovative and competitive products," says Grudzień

Graphene is a new wonder material that could have myriad hi-tech applications and may even replace silicon in the electronic devices of the future. Transparent, flexible and durable, graphene offers a huge range of potential applications in industries including aeronautics and the automotive industry, in addition to electronics, energy generation and storage, medicine, materials engineering, and environmental protection.

Karolina Olszewska