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Instead of drugs, brain implants: will a Spanish startup revolutionize the treatment of Parkinson's disease?

Elizabet Beržanskytė, LRT.lt
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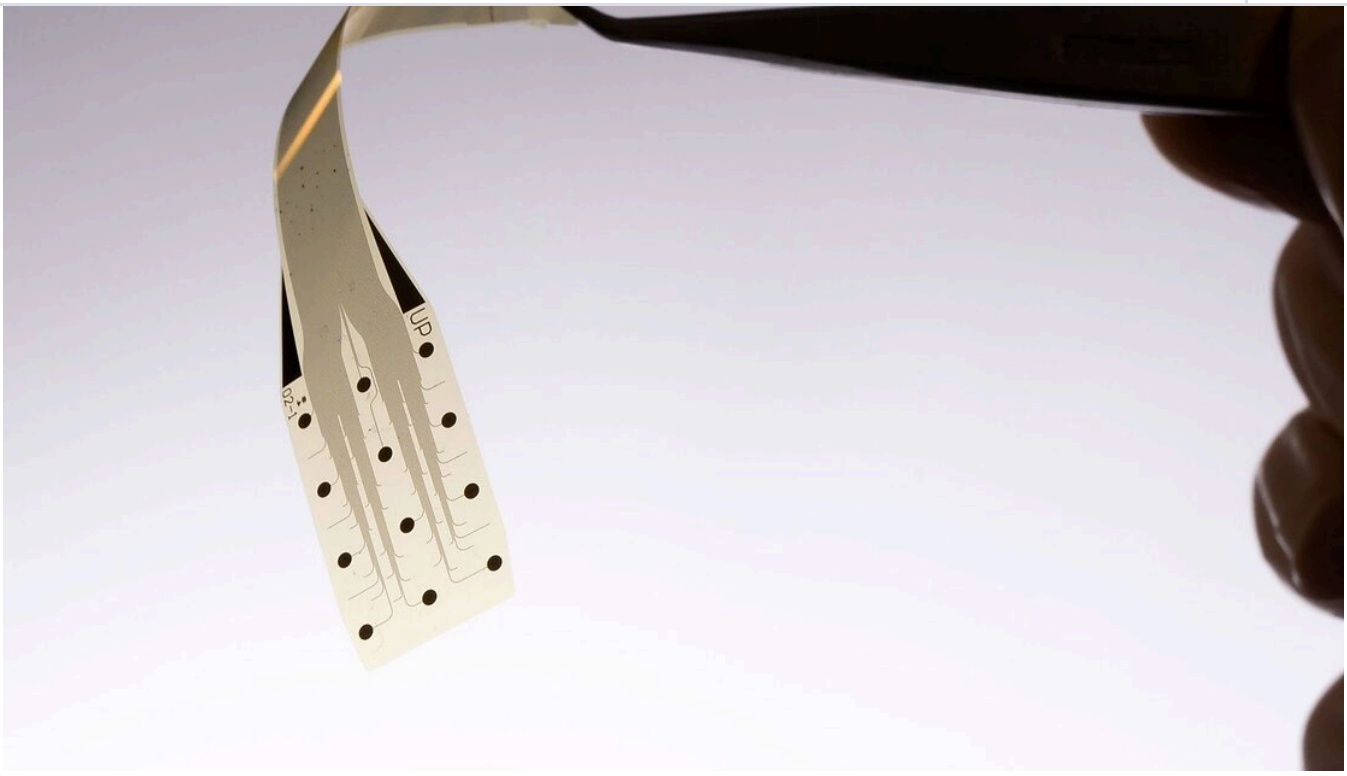

Graphene-based brain implant component currently being tested in clinical trials / Illustration by Inbrain Neuroelectronics

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With all the media attention Elon Musk's Neuralink has received, you'd think it was the only company developing brain implants.

However, this is not true. Among others, a Spanish startup is pushing forward in this sphere. According to one of the founders of the company, prof. Kosto Kostarelas, Neuralink and other similar companies are just trying to connect a person to the Internet or give them additional abilities, but the goal of Inbrain neuroelectronics is to help people tame complex diseases.

Straipsnis trumpai

- Barselonoje įsikūrusi bendrovė kuria neurologir neurodegeneracinių ligų simptomams malšinti s smegenų implantus.
- Anot K. Kostarelos, taip pat smegenų implantus Musko įmonė „Neuralink“ iš tiesų nesidomi tera
- Parkinsono ligai valdyti skirti smegenų implanta individualizuotą terapiją, nes stimuliuos smeger kai pacientui prasidės su motorika susijusios pr
- Mokslininkas tikisi, kad per artimiausius 5–6 me pavykti pristatyti galutinį produktą.
- Implantai gaminami iš ploniausios žinomos med grafeno.
- K. Kostarelos teigimu, anksčiau nanomedžiagos apipintos įvairiais mitais, pavyzdžiui, kad jos gal savarankiškai daugintis ar priimti sprendimus.
- Nanomedžiagomis apdengiami vaistai tampa st saugesni.

Brain implants that offer therapy

neurodegenerative diseases. According to the interviewer, diseases of this group are a growing problem in the world for two reasons. In particular, there are not many effective conventional pharmacological agents to treat them. Another thing, if there are any, for example, in the case of Parkinson's disease, after a certain time these tools stop working.

Kostas Kostarelas / D. Umbraso / LRT photo.

"For example, there is a drug called levodopa, which is the main drug for Parkinson's disease. Unfortunately, for many patients, it stops working after some time. Then the symptoms of the disease begin to appear, says the professor of the University of Manchester and the Autonomous University of Barcelona. - We decided that we want to help patients with neurological diseases that are not well affected by drugs. So, one of the diseases is Parkinson's disease, the second is epilepsy. It can also be any indication that requires careful and very precise removal of parts of the brain, such as aggressive brain cancer."

Parkinson's disease, associative photo. / J. Stacevičius / LRT photo.

The scientist says that the solution developed by Inbrain neuroelectronics is very different from the one developed by billionaire E. Musk's company Neuralink. According to him, Neuralink and other brain-computer interface (*BCI*) based solutions development companies are basically not interested in therapy.

> *Neuralink and other companies developing brain-computer interface solutions are largely uninterested in therapy.*

"These companies are really interested in connecting people to the Internet or giving us the ability to move or play mind games and so on. Companies developing BCI solutions are not companies offering therapy," says K. Kostarelos and adds that the Barcelona-based company, unlike others, aims to use BCI for therapeutic purposes.

The interviewer explains that brain implants designed to reduce the symptoms of Parkinson's disease consist of two elements: "One of them is what I call the traditional BCI element, that is, an implant that will be placed in the cerebral cortex of a Parkinson's patient, more precisely, in the motor part of the brain cortex, it will record brain activity. In this way, we will receive information from the patient's motor cortex. The purpose of the second stage is to stimulate the brain. So another element will be placed under the brain cortex (*subcortical), it will supply current there."*

This results in a closed loop that includes a BCI element that monitors, records and decodes the patient's motor cortex impulses, and another element that turns stimulation on or off in another part of the brain based on BCI signals. Prof. K. Kostarelos says that a similar technology is already being developed by Medtronic, one of the big leaders in this field, but Inbrain neuroelectronics aims

> *We would offer the patient a therapeutic outcome that is much more in line with their physiology. So it's going to be more personalized in a sense because it will only stimulate the brain when the patient starts having motor problems and it will turn off when the tremors go away.*
>
> *K. Costarelos*

"We would offer the patient a therapeutic outcome that is much more in line with their physiology." So, in a certain sense, it will be more individualized, because it will stimulate the brain only when the patient starts having motor problems, and when the tremor goes away, it will turn off," the scientist tells LRT.lt.

Kostas Kostarelas / D. Umbraso / LRT photo.

As for when brain implants to treat Parkinson's might appear, Kostarelos says it's not the distant future, but "it's not, you know, a robot-cloning scenario."

"Although I am one of the founders of the company that develops the mentioned implants - Inbrain neuroelectronics - I cannot answer for the company as a whole, because I do not work for it. However, we believe that we will be able to start clinical trials in the next 3-4 years.

I would say that in the next 5-6 years, if the company continues to receive sufficient funding (its investors believe in this therapeutic vision of brain-computer interface technology) and continue with its planned program, it will be realized [to deliver the final product]", - a confident interviewee .

Parkinson's disease, associative photo. / D. Umbraso / LRT photo.

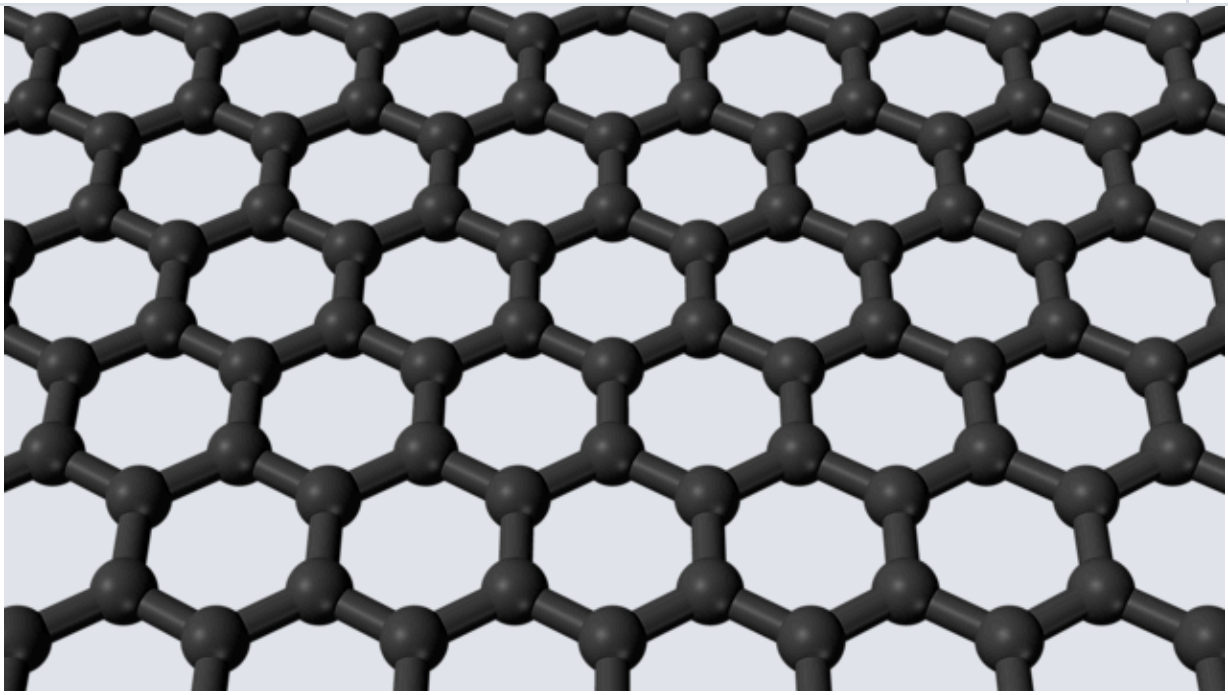
The sensitivity of implants is provided by graphene

The uniqueness of the Inbrain neuroelectronics company is that graphene is used to manufacture the implants, which provides access to a larger number of neurons and ensures that the proposed solution is more sensitive than the products developed by other companies.

Prof. Kostarelos quips that he had never planned to work with graphene, having previously studied liposomes (which are roughly 100 nanometer vesicles made up of fat-like molecules) for years, but this material seems to have chosen him.

Kostas Kostarelas / D. Umbraso / LRT photo.

"When I moved from the US to the UK and started a lab in London, I happened to hear a lecture about carbon nanotubes by someone who later became a colleague and friend. They intrigued me because of their shape. (...) I started researching them. When graphene came along, it also piqued my curiosity because I had already invested about ten years in research into elongated carbon nanotubes, which are hollow cylinders of carbon fiber. And then all of a sudden these open flat sheets started appearing and I thought, “Wow! It's even more interesting."



Graphene sheet model / Photo by Wikimedia Commons.

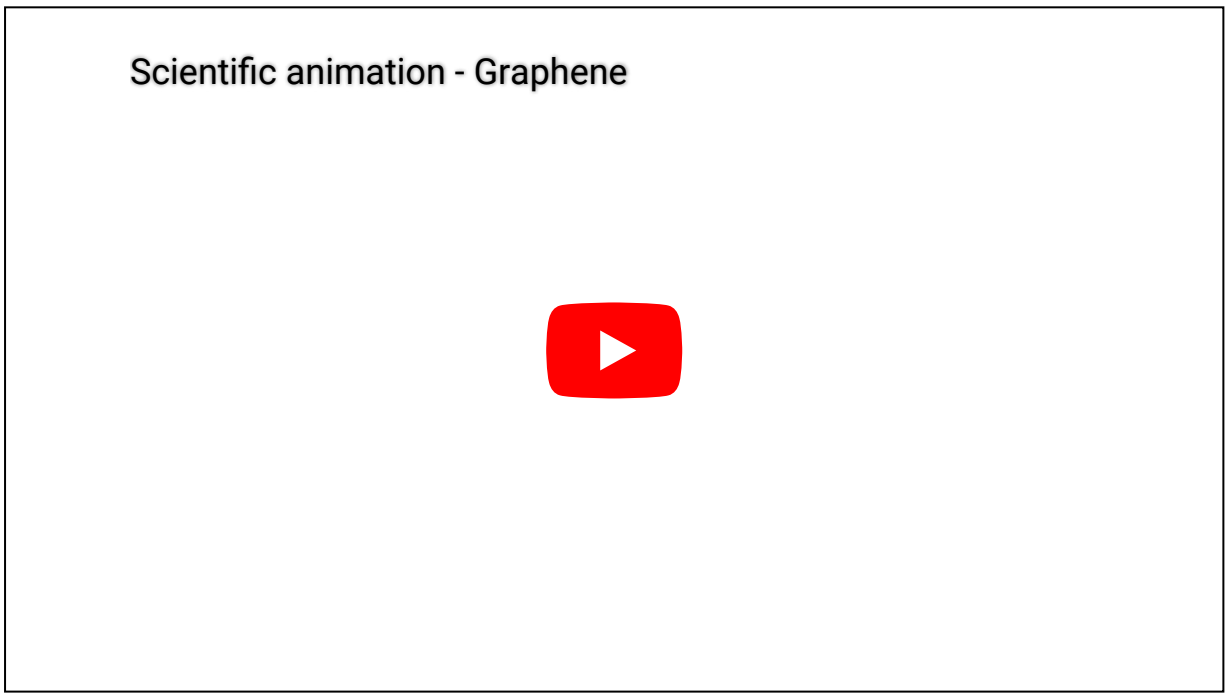
Graphene sheets are one atom thick (one of the thinnest materials known to date), transparent, electrically conductive, flexible, mechanically durable. However, no one knew if they were compatible with our body, which was what interested the professor the most.

According to him, at first it was not obvious that devices made of graphene could be implanted in the brain. The most popular application of graphene has always been biosensors (medical devices that operate outside the human body and are designed to monitor or measure various biological parameters).

> *My colleague and I kind of convinced each other that we should go for something more sophisticated, higher class and a little more technologically advanced, but not Hollywood crazy.*
>
> *K. Costarelos*

never felt that we had a compelling enough proposition in this area." What do I mean by "convincing"? I thought we could do the same reasonably good job [creating biosensors with the same accuracy] with some other material without using graphene," says Professor K. Costarelos of the University of Manchester, adding that he has always believed that graphene has much more to offer.

The scientist says that it was through this kind of thinking that he and his colleague sort of convinced each other that graphene should be applied to create something more complex, higher class and a little more technologically advanced, but not Hollywood crazy.



"That's where the idea of developing neural interface implants came from, because you need something that is stable and strong. Also, of course, electrically conductive. The material then needs to be transparent enough to be implanted in the brain for magnetic resonance imaging. (...) Among other properties that are important for implants, corrosion resistance is important - it is necessary that there is no such wear that causes problems. In addition, the material must provide an opportunity to reduce the size of the device", says the interviewer and assures that graphene could offer all this.

There are many materials based on very exotic elements, and those materials have very interesting properties. But I couldn't even think about talking to the regulators to convince them that it's safe to inject into a human. Therefore, graphene won."

Kostas Kostarelas / D. Umbraso / LRT photo.

in 2013 the company started animal experiments to find out if graphene is even compatible with a living organism. The durability of the material was also studied.

"It was important to prove that the material doesn't flake and you don't flood the brain with graphene fibers." In the worst case, even if the material peels off a little or a few tiny pieces fall out, it doesn't have to be harmful, the body has to deal with it," says the professor.

Tests on animals have shown that graphene can be used in the manufacture of implants currently under development, as expected. in 2021 In an interview *with sifted.eu,* the CEO of Inbrain neuroelectronics, Carolina Aguilar, said that

Photo by Neuralink/Shutterstock.

Hollywood movies distort the perception of nanomaterials

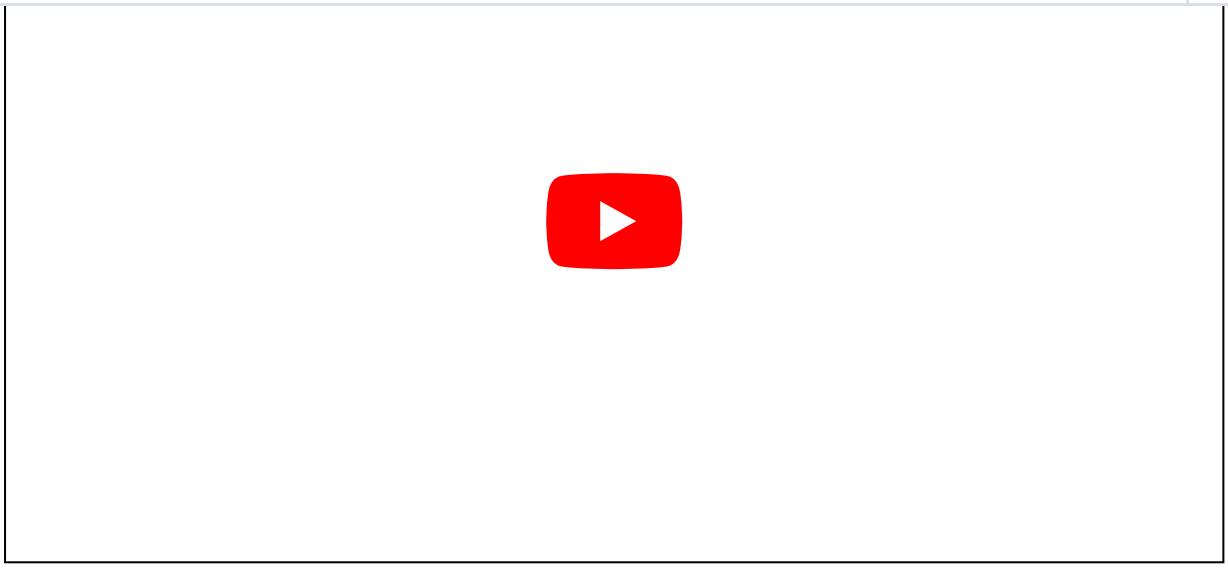
Graphene, which has been talked about a lot before, is a nanomaterial. Nanomaterials are materials of the order of nanometers. A nanometer is one millionth of a millimeter, a dimension about 100,000 times smaller than the diameter of a human hair.

K. Kostarelos aims to apply graphene in medicine, he is a professor of nanomedicine.

Kostas Kostarelas / D. Umbraso / LRT photo.

"Nanomedicine is the use of nanomaterials (...) in the engineering and development of medical devices, medical products, medical technologies, including drugs, biotechnology, and in recent years increasingly devices that interact with the body or are *ex vivo* (adjacent to it)", - he explains, adding that in the beginning, people used the term "nanomedicine" incorrectly to describe a rather controversial concept that was promoted by Hollywood.

"Robots are a prime example. We have Hollywood movies like Fantastic Voyage is a classic example where a submarine with a crew of 4 or 5 shrinks to a miniature size, then it's injected into the bloodstream, travels around the body, and a laser used by the crew destroys the clots and cells attacking the vessel. These are very Hollywood ideas," says the editor of many nanomedicine scientific journals.



According to K. Costarella, the Hollywood imagination of nanomaterials is not the only myth associated with them. Another common misconception about nanotechnology that really caused a lot of problems in the early days of nanotechnology development is the belief that nanomaterials will start to reproduce themselves.

"Prince Charles, who is now King Charles, began to communicate with the Daily Mail at the time and said that nanomaterials will lead to an ecological disaster in the future, because they will start to reproduce by themselves and destroy nature. All this is, of course, absurd, because nanomaterials do not reproduce by themselves. I have never come across anything that reproduces by itself, except for mammalian or non-mammalian (bacteria, fungi) cells," comments the professor.

Kostas Kostarelas / D. Umbraso / LRT photo.

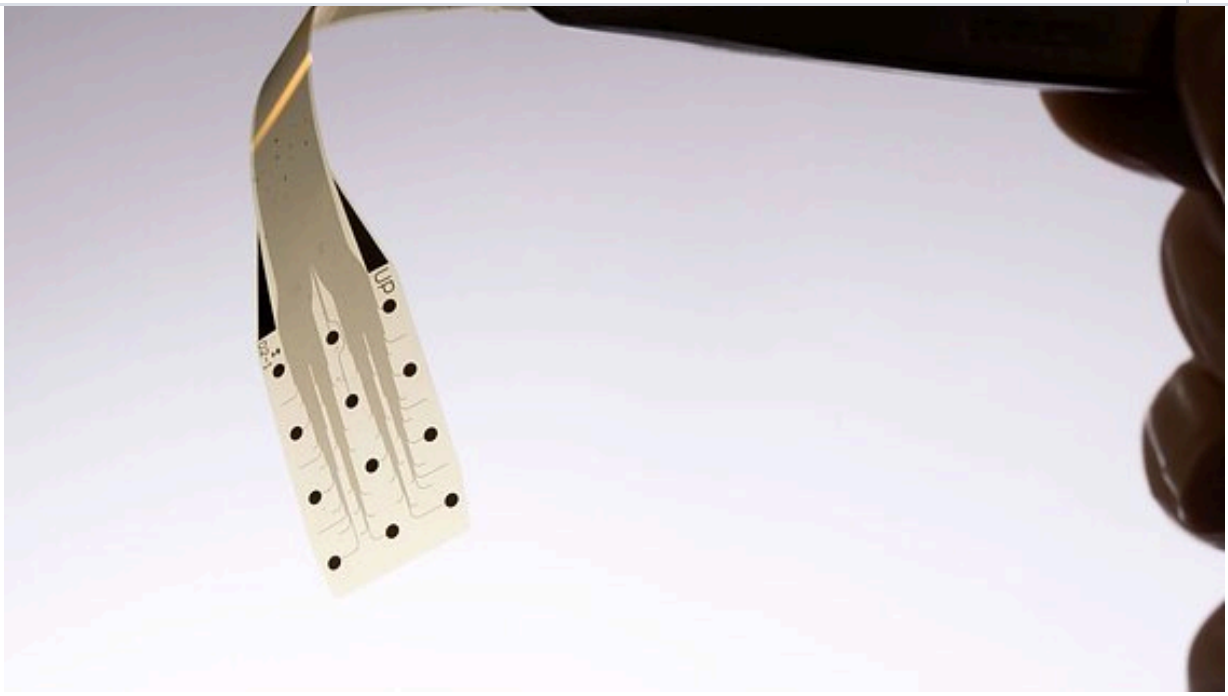
Nanomaterials are widely used for medical purposes

It is important to dispel the myths surrounding nanomaterials and nanomedicine and to mention that particles created at the nanoscale have been used in medicine for many years. Only they do not reproduce by themselves and are far from resembling self-decision-making robots. Nanomaterials, which have been developed since the 1960s, are used in two areas: the coating of implants and the delivery of components of vaccines, chemotherapy and other drugs inside the body.

"One of the goals is to make medicines safer. Such drugs, for example, are doxorubicin. If you compare injections of pure doxorubicin to injections of liposomal doxorubicin, where the drug is encapsulated in a lipid globule, you will see that the cardiotoxicity profile of the drug is significantly lower.

Vaccination against COVID-19 / J. Stacevičius / LRT photo.

The second example I'll give you is a more recent, more modern example, the vaccines against COVID-19. If you inject pure mRNA into the body, before it reaches its target, the molecule will be broken down by enzymes. When you coat it, the molecule remains stable and active for longer, reaching its target," concludes Professor K. Costarelos of the University of Manchester and the Autonomous University of Barcelona.



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