# Botox for

**Krzysztof Fic, ME, PhD,** conducts innovative research on the aging process of energy storage and conversion systems. In 2017, the European Research Council (ERC) awarded him a "Starting Grant" for the quite originally entitled project *'If immortality unveil...' – The development of novel types of energy storage systems with excellent long-term performance*. He is also a winner of the VENTURES competition of the Foundation for Polish Science. Member of the Polish Young Academy.

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**Dr. Krzysztof Fic** of the Poznań University of Technology discusses energy storage, aesthetic medicine's quest for immortality, and how much time goes into being a scientist.

ACADEMIA: **Nearly everyone knows how energy is obtained, but not many people realize just how difficult it is to save this energy for later. Let's start by asking about why energy storage is necessary in today's world.**

KRZYSZTOF FIC: Firstly because energy consumption is continuously growing. We've gotten used to the technologies that surround us every day and we don't like to be restricted. These days we don't go anywhere without a mobile phone, a tablet or laptop, all of which require the storage of energy so that it can be used at any time and place. This creates a big playing field for energy storage and conversion systems, in other words: electrochemical cells and batteries.

**What types of systems are used for this purpose?**

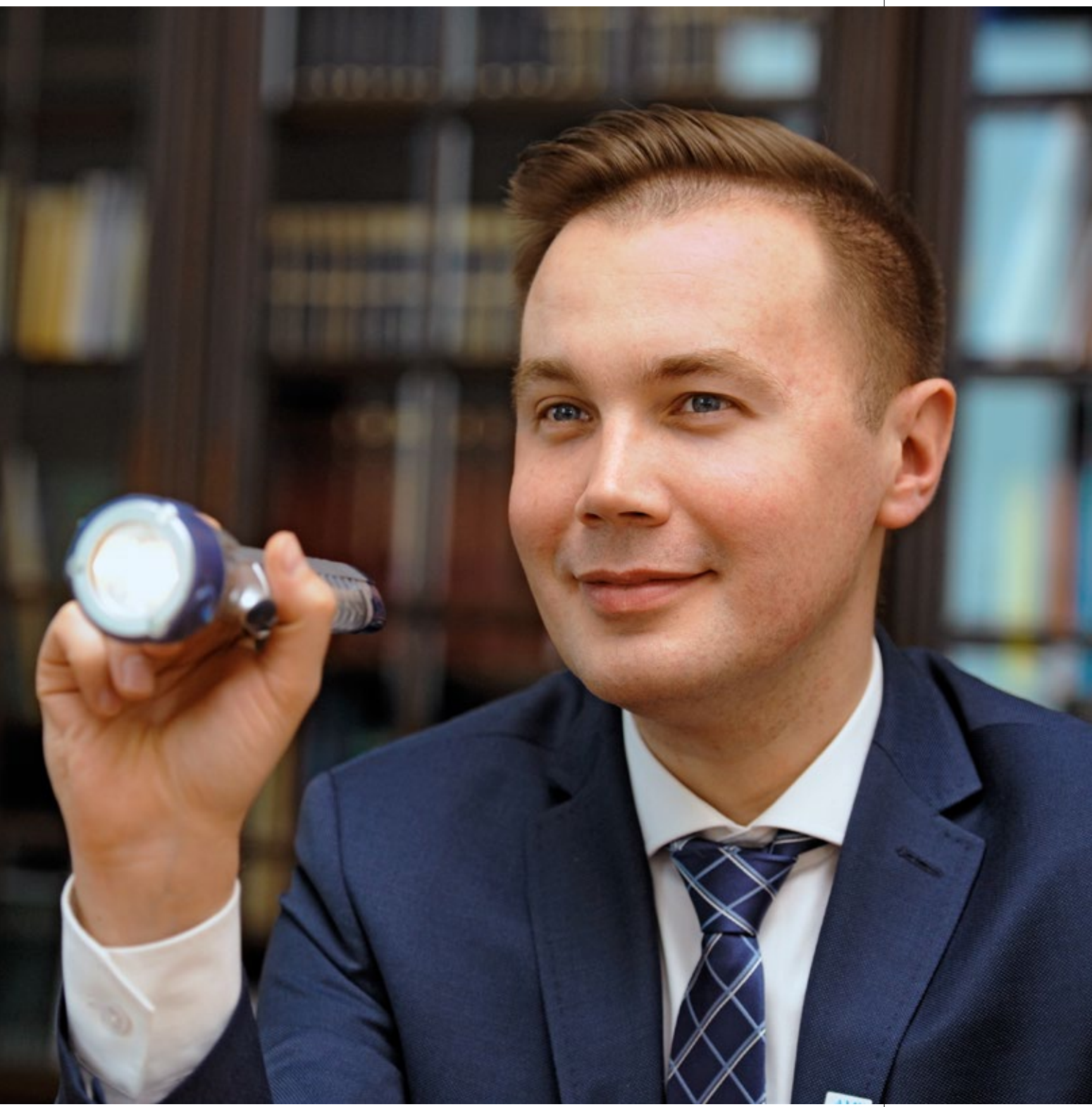
They are based mainly on chemical reactions known as redox [*a combination of the words "reduction" and "oxidation" – editor's note*]. We store energy in the form of electricity in chemical compounds or in processes that take place in energy cells. The mechanism of these processes is well known. In practice, however, creating such cells is still a huge challenge. You need to ensure an optimal compound design and concentration, and make sure it's constructed in such a way to ensure the device is resistant to temperature changes or weather conditions. Hence the multitude of systems – for use in various conditions.

**What do you mean by the term "cells"?**

A cell is a system in which two electrodes are immersed in an electrolyte and separated by a separator. Electrodes, which are in contact with each other through the electrolyte, can be made of various chem-

DR. KRZYSZTOF FIC

# BATTERIES



ical compounds that are able to store energy in their chemical form. Electrochemical capacitors provide another way. They involve a slightly different method of energy storage, based on the principle of electrostatic attraction and repulsion. This is exactly the same process that causes static on our clothes. In electrochemical capacitors electrodes are made of materials with a well-developed surface, most often active carbons. They have a surface area of 1000–2000 $m^2$ per gram of carbon. By comparison, a small football field has a surface area of about 900 $m^2$. An electric double-layer is formed on this surface with the polarized electrode negatively attracting the positively charged ions, while the other electrode attracts opposite charges. Electrochemical capacitors store the energy at this interface.

**We were intrigued by the title of your ERC grant: "If immortality unveil… ", a line taken from an Emily Dickinson poem. Here does it refer to the immortality of energy cells?**

After ten years of working in my field, I realized that while science is moving forward, we have nearly exhausted our methods for accumulating energy. At some point we will hit a wall, running out of storage methods. Even if we choose optimal electrodes for the capacitors or cells, we still have a problem of these cells aging. A battery can be recharged about 1000–1200 times, after which it must be replaced. I decided that what is most important at this point is to identify the mechanism that is responsible for the deterioration of the cell quality. The key right now is not to develop new materials, but to answer the question why those we already have and which are very good are getting old. It's the same as with humans. Today we know why people die and where the aging process stems from, but we still don't have the medication to stop it. We do, however, have aesthetic medicine. I am trying to answer the question why electrochemical cells and capacitors age. Once I have the answer, I can design a process that will block these mechanisms. Just like Botox. Such a boost will allow us to use the cells for longer.

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**That's a major issue and a massive undertaking. Are you addressing it yourself or with a team?**

I won't attempt to be original, instead I will quote a wise saying that I heard somewhere in America: *If you want to go fast, go it alone. If you want to go far, go together*. Indeed, you can do certain things yourself, but with the current state of knowledge that work would be very superficial. I am an electrochemist myself, and I think it's great that we are able to create a team that brings together various skills, abilities and interests. In my opinion, the key to this project's success lies in collaboration. I certainly would not be able to do this on my own. This is why I am taking my time to create a research team and establish cooperation. Mainly international, because this is not a well-developed area in Poland.

**Will the research team be located in one place, or are there plans for remote work and occasional meetings?**

This project was developed at the Poznań University of Technology. This is where I have my laboratory, where the main research takes place, and where I hire my team members. However, some of our partners from various regions of the world work from their respective locations. We compare results, exchange ideas and people. This allows some of us to work in different labs for a month or two, observe processes we don't work on here since we specialize in different fields. Others can also come visit us, see what our work looks like. The part of the project that requires collaboration, such as checking new materials, takes place in our partner labs, which we visit.

At the moment we are working closely with a French lab in Mulhouse, where they have vast knowledge when it comes to material chemistry. We also work closely with Switzerland and are in the process of establishing cooperation with Japan and, of course, with America, the leaders in the fields of science and infrastructure. You can't overestimate the scientific atmosphere at some American universities where you can meet all kinds of famous scientists and talk to them over coffee. This can often lead to interesting discussions and ideas.

**You are responsible for executing the project. The science part is one thing, but how do you deal with the managerial and administrative aspects?**

I think that the main obstacle is the paperwork. In Europe, receiving such a grant is a positive thing, while in Poland on the one hand you're pleased to receive a grant, as it's quite an accomplishment, but on the other, everyone seems to be afraid of it. This is a huge grant and it carries with it a lot of responsibility. It's difficult administratively in the sense that we do not have procedures in place that would allow us to act quickly and decisively. Though when it comes to the

administrative part itself, I have to admit, I have decided to focus right now on the academic side, on creating my team and on educating young people who want to work with us and help us. The university offers some help, but it would not be possible to work on this grant without the support of the Bureau for Scientific Excellence of the Polish Academy of Sciences and the National and Regional Contact Point of EU Research Programs. Administratively, the undertaking is huge, and it requires procedures that have been very rarely applied in Poland due to very few such grants being awarded. This is due to a previous lack, not so much of experience as of knowledge about how certain Polish regulations can be applied.

**Did anyone help you prepare the proposals in a way that would convince the commission to choose your project?**

As far as the formal side and general guidelines were concerned, I turned to the PAS Bureau for Scientific Excellence, who were able to clearly explain everything to me. The National Contact Point for EU Research Programs helped me with administrative issues related to such matters as obtaining a grant for a specific university, in a specific lab and with the possibility of recruiting staff. As for the application itself, in the end I decided to go ahead and write the project in my own way. That's the reason for the somewhat crazy and unusual title. I decided that reading an umpteenth project proposal, arguing that energy storage is difficult, must be extremely boring. That's why I opted for a style of asking the reader philosophical questions, in order to get closer to their subject and say: look, even if your subject is philosophy or ancient history, my subject is still relevant, because you use a smartphone, tablet, electric toothbrush and that's exactly what this project is dealing with. This is how I went from the general presentation of the topic to showing what I would do in a strictly scientific way. I received some criticism that the proposal was oddly written. But I wrote it the way I wanted to and sent it off. I braced myself for rejection, but in the end it turned out that it was a good idea to sell my concept in such a simple way. I think reading and writing project proposals in a clichéd manner is boring and kills creativity.

And yet, when I received my invitation for an interview, I was very surprised. Waiting for this presentation has been the worst three months in the last ten years of my life. I had to fight for a huge grant, using just three slides in a five-minute presentation. I must admit that when I heard this I was worried. How could I convince eighteen panel members with three slides that I was the right person to give this much money to? But I did it.

**Did you really manage to fit it all into five minutes?**

There's no way you can go over five minutes. There are three clocks hanging in the room, so no matter which direction you look, you can see the time ticking away.

**This is a long, five-year project. Does working on this grant leave you with any free time at all? Or will your whole life revolve around energy cells and working with the teams?**

This is a very difficult question because I really don't know how to answer it in a way that won't discourage future grantees. I believe we should change the approach somewhat. You are a scientist 24 hours a day, 7 days a week, so working nine-to-five is not an option and won't bring the results you want. On the other hand, I could say that for the past ten years there haven't been a single day that I did not work at all. I have a great time doing what I do and I enjoy being a scientist. Work makes sense when you love what you do. But that doesn't leave me with much time for myself because the possibilities offered by this grant are huge and we must take advantage of them. Also, a grant from the ERC is a great honor and we can't let them down.

> There's a wise maxim I heard in America: "If you want to go fast, go it alone. If you want to go far, go together."

**Finally, perhaps a question for the future: are you planning collaboration with industry, or any practical applications at various stages of the project?**

As a former technology student now working in this field, I love things that are useful. I believe that as a scientist I have a responsibility to provide solutions that can serve others. I did not focus on general applications in this project, thinking that it is too early for the product or process itself. However, I can't completely rule it out. The ultimate long-term goal is to develop a system with improved energy storage capacity. The project itself, however, is strictly scientific in nature, because often the work also closes off certain research areas. So, I focus on science, but I try to strive for solutions that can be used in real life.

Interview by
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