

Conductive biopolymers using recycled food industry byproducts

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Advanced Materials recently published the findings of Technion researchers who created conductors relevant to solar energy generation, biomedical engineering, and more using by-products of the food industry

that would otherwise be discarded as waste. The technology demonstrated in the article allows for the simple, fast, cost effective, and environmentally friendly production of biopolymers, which include application for electrophysiological signal sensing.

The study was conducted in the Schulich Faculty of Chemistry under the leadership of Assistant Professor Nadav Amdursky, Head of the Biopolymers and Bioelectronics Laboratory, and doctoral students Ramesh Nandi and Yuval Agam. According to Prof. Amdursky, "The current global green trend has not bypassed industry, and numerous groups worldwide are working on new solutions that will limit the pollution caused by the production of synthetic materials and by their very presence. One of the options is, of course, the use of natural materials, and the big challenge is to adapt them to meet needs."

The two main approaches in environmentally conscious chemistry are environmental chemistry—the creation of environmentally friendly materials; and sustainable chemistry—production based on available degradable materials and energy-efficient processes. The present research integrates the two approaches in an environmentally friendly production process that yields environmentally friendly products in the context of conductive polymers.

Polymers are long chains made up of thousands of building blocks called monomers. Silk, wool and cotton fibers are examples of natural polymers, whereas nylon and PVC are [synthetic polymers](#). Conductive polymers are a subgroup of polymers, and they serve for a vast variety of applications: electronics, energy storage, fuel cells, medicine, and others. These polymers are currently produced using processes that are costly and cause pollution due to the use of derivatives of oil, gas, and fossil fuel.

The alternative proposed by the Technion research team is protein

polymers—molecules that are present in different biological tissues such as silk and wool fibers, spider webs, hair, and nails. Here, as mentioned, they are by-products of the food industry that would otherwise be discarded as waste. According to Prof. Amdursky, "The inspiration to use proteins to create [conductive polymers](#) originated in the unique function of proteins in nature—they are exclusively responsible for transporting various charge carriers in flora and fauna; for example, in cellular respiration or in photosynthesis in plants."

The researchers created transparent [polymer](#) films with high conductivity. This film is suitable for biological and biomedical applications since it is non-toxic. It is biodegradable in the human body, and can be stretched to approximately 400% of its original length, without significantly impairing its electrical properties. Its conductivity is among the highest detected in biological materials.

According to Prof. Amdursky, "The production of the film in our research was a one-pot process, spontaneous, inexpensive, fast, energy efficient, and nonpolluting. In the article, we demonstrate the use of the film as 'artificial skin' that noninvasively monitors electrophysiological signals. These signals play a meaningful part in brain and muscle activity, and therefore their external monitoring is a highly important challenge."

Prof. Amdursky emphasizes that since this technology is designed for application and commercialization, "the economic consideration is key, and consequently, it is most important to lower the costs of production processes so that they will yield a product that is competitive, also in terms of price, with petroleum-based polymers, and happily, we have succeeded. This is in addition to the reduction in environmental damage in the production phase as well as during use. The new polymer is fully biodegradable in less than 48 hours, as opposed to synthetic polymers, which are not biodegradable and as result, pollute our planet."

More information: Ramesh Nandi et al, A Protein-Based Free-Standing Proton-Conducting Transparent Elastomer for Large-Scale Sensing Applications, *Advanced Materials* (2021). [DOI: 10.1002/adma.202101208](https://doi.org/10.1002/adma.202101208)

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