RESEARCH NEWS

Sustainability

Bio-based plastics — innovative plastic film material made from PLA

Flexible, disposable plastic films used in shopping or garbage bags are made mainly from petroleum-based low-density polyethylene (LDPE). These films, however, come with a large carbon footprint and contribute to environmental pollution. A team from the Fraunhofer Institute for Applied Polymer Research IAP has now developed a flexible and recyclable plastic film material based on polylactide (PLA) bioplastic and paved the way for its commercialization. For their efforts, they will receive the Joseph von Fraunhofer Prize for 2024.

Recycling and defossilization play a crucial role when it comes to sustainable plastics. After use, plastics are ideally broken down into their basic components, which are used to produce new plastics with the same properties. However, part of the material is lost in the cycle of production, use and reuse. "To further advance the circular economy, these losses must be offset by non-fossil raw materials. This, however, poses a challenge since there are usually not any bio-based counterparts for fossil plastics with the same material properties," says Dr. Antje Lieske, Head of the Polymer Synthesis department at Fraunhofer IAP in the Potsdam Science Park. "Although these properties can be improved through various additives, these interfere with recycling processes further down the line. In addition, they can be expensive and harmful to the environment, and, above all, they are not bio-based," Lieske adds.

Material and process development based on PLA

The biopolyester PLA is a promising approach to solving this problem: It is bio-based, biodegradable, easily recyclable and has one of the strongest market potentials when it comes to bioplastics. Due to its high stiffness, it is perfectly suited for rigid packaging such as disposable cups — but not for flexible disposable packaging such as shopping bags, which are one of the main sources of disposable plastic waste. Dr. Antje Lieske has solved this problem together with her colleagues André Gomoll and Dr. Benjamín Rodríguez at Fraunhofer IAP.

"We coupled plasticizers, so-called polyethers, directly with the polymer chain to make the material more flexible over the long term. Polyethers are non-toxic, commercially available and can also be produced from bio-based raw materials. Until now, plasticizers have been mixed into PLA as additives. However, the plasticizer molecules migrate

Contact
Monika Landgraf | Fraunhofer-Gesellschaft, München | Communications | Phone +49 89 1205-1333 | presse@zv.fraunhofer.de
Dr. Sandra Mehlhase | Fraunhofer Institute for Applied Polymer Research IAP | Phone +49 331 568-1151 | Geiselbergstrasse 69 | 14476 Potsdam, Germany | www.iap.fraunhofer.de | sandra.mehlhase@iap.fraunhofer.de

out of the material over time, making the PLA stiff and rigid again. To prevent this migration, we anchored the polyether to the polymer. To achieve this, we synthesized PLA-based block copolymers in which the polyether chain segment is covalently linked to PLA chain segments at both ends," explains Dr. Benjamín Rodríguez.

Sustainable and flexible plastic with great potential

The result is a novel, flexible PLA material that does not contain migrating plasticizers and, unlike LDPE, is at least 80 percent bio-based. "In the long term, we might be able to increase this proportion to almost 100 percent," Gomoll explains. "In addition, our material can be produced cost-efficiently from commercially available raw materials in a simple synthesis process. This process does not require large-volume synthesis plants but can be implemented locally by medium-sized companies as a continuously operated process. Until now, PLA could only be produced profitably in continuous large-scale plants, which excluded smaller companies as manufacturers. Finally, the new PLA material can also be processed into plastic films using conventional processing equipment in a similar way to LDPE — and it can be chemically recycled with considerably less energy input than LDPE," Gomoll continues.

These unique material properties prompted the Polymer-Group company to commercialize the material. In 2023, SoBiCo GmbH, a subsidiary of the Polymer-Group, commissioned a production plant for the new PLA block copolymers in Pferdsfeld (western Germany). It produces 2,000 tons of the new bioplastics per year under the name Plactid®. In the long term, it is set to produce 10,000 tons of the new flexible PLA material each year.

The new class of bioplastics will make an important contribution to making plastic packaging materials more sustainable. In addition to flexible packaging films, the new material might also tap into completely new use cases, e.g., in the automotive sector, in the textile industry and in additive manufacturing.

Joseph von Fraunhofer Prize

Since 1978, the Fraunhofer-Gesellschaft has awarded the annual Joseph von Fraunhofer Prize to its employees for outstanding scientific achievements in developing solutions for practical problems. This year, three prizes, each worth 50,000 euros, will be awarded to groups of researchers from different institutes.

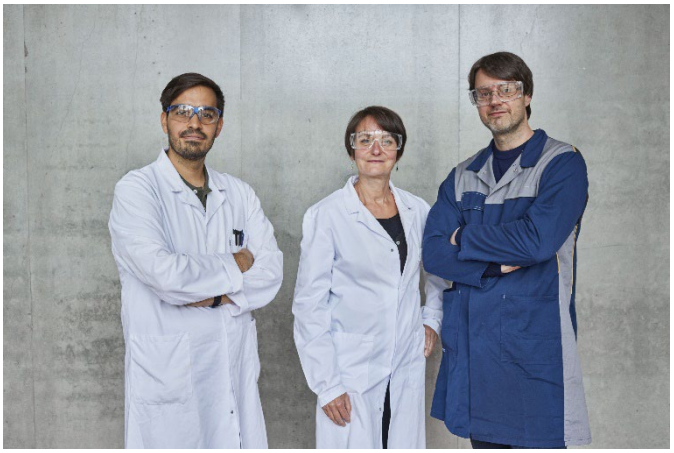

Fig. 1 The team of researchers from Fraunhofer IAP: Dr. Benjamín Rodríguez, Dr. Antje Lieske and André Gomoll (from left to right)

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Fig. 2 The new PLA material can be processed into plastic films in a similar way to LDPE using conventional processing plants.

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