

Bio-based raw materials are making shoe production more environmentally friendly

On green soles

Climate protection begins with our shoes: the plastics and rubber for our footwear are currently still being made primarily from fossil-based resources. Researchers at Bayer have now developed a concept shoe called the "EcoTrekker", in which many of the components were manufactured from renewable raw materials. These replace petroleum chemistry-based components and improve the CO₂ balance of footwear.

Without shoes we would be virtually immobilized: people need protection for their feet, whether it's slippers, sandals, sports shoes or ballerinas. After all, each person covers an average of several thousand kilometers in shoes during the course of his or her lifetime, wearing those artificial soles out in the process. Worldwide, approximately 20 billion pairs of shoes were produced in 2010 alone. Half of them were made in China. Statistically speaking, that is equivalent to more

than one pair of shoes from the People's Republic per year for each person on earth. The majority of these shoes are made of plastics and rubber: some 500,000 tons of polyurethane (PUR) are used annually worldwide just to make shoe soles. "Polyurethane is ideally suited for shoes due to its extreme durability and the theoretically unlimited design freedom it offers," says Dr. John Zhang, Head of the Global Footwear Competence Center (GFCC) at Bayer MaterialScience in Shanghai.

At present, conventional plastics and rubber in the shoe industry are based almost entirely on oil. Zhang and his employees at GFCC want to change that: they have sent a "green shoe" – known as the EcoTrekker – on a trip around the world. In this shoe, fossil raw materials have been replaced with renewable materials such as corn starch or by-products from the sugar industry.

"In particular the booming outdoor sector is all about experiencing nature. Bio-based plastics for trekking or hiking shoes are naturally an especially good fit here," explains Marius Wirtz, a plastics expert with Bayer MaterialScience in Hong Kong. Globally leading shoe manufacturers – including adidas, PUMA, Nike, Timberland and UVEX – have publicly committed themselves to more environmentally friendly materials and low-waste production. "Consumers are becoming steadily more environmentally conscious and are willing to spend more money for sustainable products," says Wirtz.

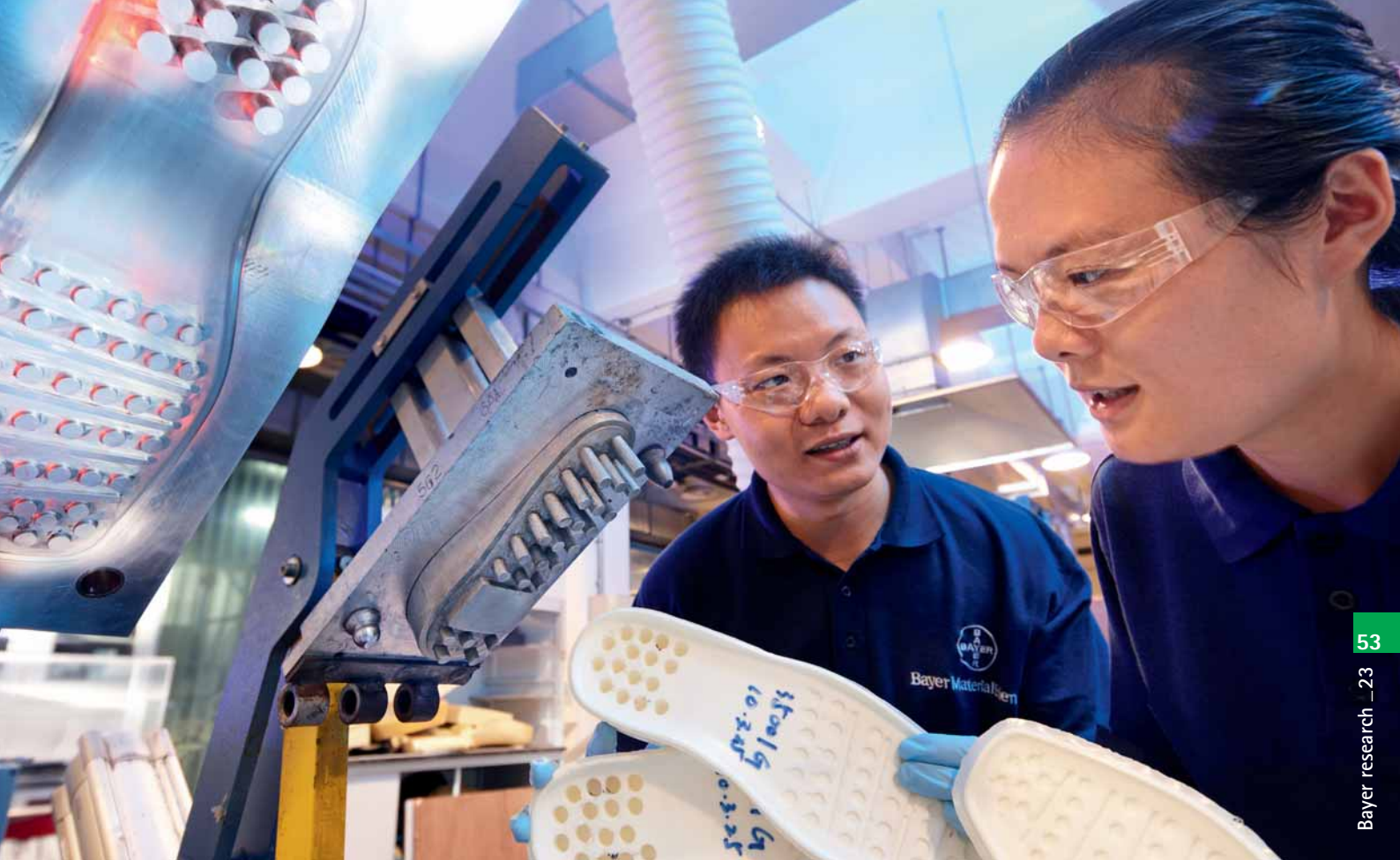
Concept shoe: 90 percent environmentally friendly materials

In the future, even joggers and other sports enthusiasts and factory workers can look forward to wearing bio-based soles: based on its weight, the green shoe concept consists of 90 percent environmentally friendly materials – from the polyurethane shoe sole to the thermoplastic polyurethane (TPU) eyelets for the shoelaces. The

Climate protection in a shoe



All in all, up to 90 percent of the components in the concept shoe have environmentally friendly characteristics. Among other things, these include solvent-free coatings and adhesives as well as materials made of thermoplastic polyurethane (TPU). In addition, the polyurethane soles contain no heavy metals that remain after disposal.



Material experts at work: Xiang Liu and Erika Zhu (from left) evaluate freshly poured soles for the EcoTrekker. Conventional raw materials have been replaced with renewable resources such as corn starch and sugar industry by-products in the making of this new green Bayer concept shoe.

researchers at Bayer produced the front cap for a safety shoe prototype from a highly impact-resistant blend of polycarbonate and polylactic acid (PLA). Lighter than conventional steel caps, it can also be recycled.

"The biggest difficulty was adapting the bio-based raw materials to the requirements for shoe manufacturing," says Zhang. The most important source materials for polyurethane are polyols and isocyanates. Until now, the processes for transforming both basic chemicals into plastics and rubber for the shoe industry were entirely tailored to the crude oil-based components. However, bio-based polyols are more viscous than their oily competitors. "They also differ considerably in terms of their processing characteristics," says Zhang. The Bayer researchers had to adapt their bio-based polyols specifically to industrial production in order to ensure factors

such as processability: "Bio-based polyurethane has the same characteristics as conventional polyurethane," says Wirtz.

The EcoTrekker is not just environmentally friendly, it also improves the work safety of the employees involved in production: the coatings and adhesives used are water-based and free of organic solvents, which can prevent workers' potential exposure to toxic chemicals during production.

Bio-based raw materials optimized for industrial production

In contrast to conventional polyurethane, Bayer PUR contains no heavy metals either. Furthermore, the limited edition concept shoe is equipped with a counterfeit-proof label based on a high-quality polycarbonate film from the Makrofol™ ID range. A laser engraving procedure is used to create

the label, and security features such as holograms can be incorporated as well (see also *research* 21, "The sparkling fingerprint").

In order to ensure that the renewable raw materials being cultivated in the field do not compete with foodstuffs or make them more expensive, the Bayer researchers are already working on the next generation of plastics: these are based entirely on plant waste or even on the climate offender CO₂ (see also p. 80, "Three atoms for a clean future"). In the future, nature lovers could be hiking on green soles.



www.research.bayer.com/green-shoe
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