THE “GREEN” FUTURE OF BROWN TAPES

In cooperation with the Hamburg University of Technology (TUHH), tesa has been researching the industrial applications of the wood component lignin for the past five years. In the future, this bio-based raw material could add a unique touch to some tapes.

Once upon a time, there was a miller who was very poor. But he had a very beautiful daughter. One day he came before the king and said to him: “Your Majesty, I have daughter who can spin straw into gold.” So begins “Rumpelstiltskin,” the famous fairy tale by the Brothers Grimm. The idea of transforming straw into a precious metal sounds enticing, but at most only works in the magical world of fairy tales. However, it is possible to process straw and other wood residues to create an extremely versatile raw material for diverse applications: lignin.

Renewable resources are gaining increasing attention in the chemicals industry, which is overly reliant on carbon-based compounds for manufacturing products such as paints, plastics, and adhesives. In Germany alone, 87 percent of these compounds stem from fossil fuels, including petroleum, gas, and coal. “Lignin is interesting because it is available in large quantities and costs for the source material are low,” says Cai Rong Lim, tesa laboratory manager in the Rubber Technology & Renewable Materials department. “Due to its high functionality, lignin can also be easily processed with other substances, for example resins and additives; it could replace today’s filler materials, such as calcium carbonate (lime), and possibly even extend the life of tapes,” adds Lim.

ON THE WOODEN PATH WITH THE UNIVERSITY

To determine the potential of the valuable lignin from an ecological perspective, and later “tap into” the potential for industrial applications from an economic standpoint, tesa started the “Biorefinery 2021” project with TUHH. The project has been funded by the German Federal Ministry of Education and Research since 2013. In the first phase, Dr. Tobias von Wedel-Parlow headed the project; since 2016, chemist Cai Rong Lim, supported by Christian Kreft, has been responsible for the cooperation.

This is how the public private partnership (PPP) works in practice: In the technical center at the university in Harburg, students obtain the lignin primarily from wheat straw. In a process similar to brewing coffee, hot water (200°C) is pressed under high pressure (50 bar) through the shredded straw. This process is called hot water hydrolysis.

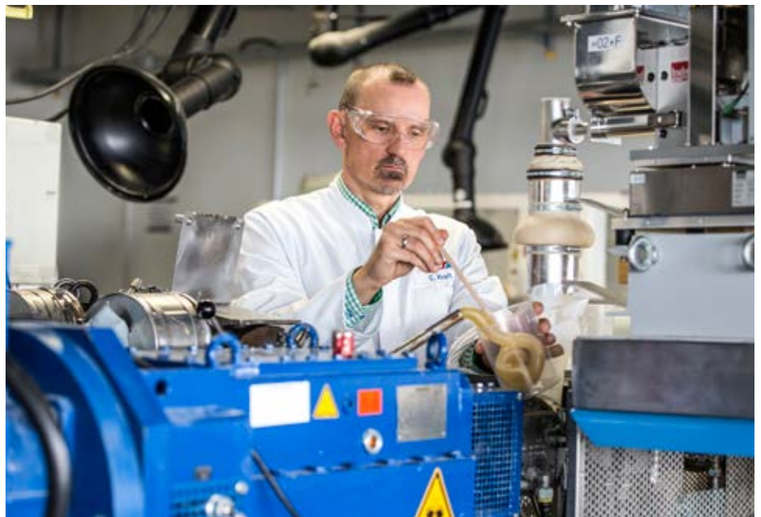
In the next step, enzymes are added to the solid material, which break it down into sugar (cellulose) and lignin. The sugar can be further processed to make biofuel, for example. In the form of a fine powder, the lignin arrives in the tesa research center, where Lim and her team mix it with natural rubber and resin. In the technical center, they then knead the mixture, spread it onto paper or film, and let it dry. Various tests round off the procedure.

“Overall, we were able to achieve the goal of working the lignin into established mass formulations,” Lim recently wrote in her final report for the third project phase. “A visually homogeneous layer of the adhesive mass can be seen, depending on the lignins used; on some samples, however, moderately noticeable inhomogeneities and larger particles are detected.” Christian Kreft points out that the raw material has a particular “note”: “Without further chemical treatment, the brownish coloring of the masses is just as unavoidable as the typical fragrance of wood.” Therefore, lignins are probably not suitable for transparent tapes but rather for packing tapes or other products with brown paper materials.

So far, the process technicians at TUHH have only been able to produce around a ton of lignin per year. And elsewhere, extraction of the bio-based raw material on an industrial scale is only just beginning. Nevertheless, Lim is convinced of lignin: “Thanks to our close cooperation, we have learned a lot about current research in the area of bio-based raw materials, which will gain enormous importance in the future.” And the university benefits, too: a few doctoral dissertations have already resulted from the project – and the students come into contact with a potential employer. The only thing missing is a fairy tale goblin who makes gold out of straw…

By Gunnar von der Geest

Christian Kreft mixes the lignin powder provided by TUHH with natural rubber and resin. In the technical center (below right), a new adhesive mass is produced in a small amount. The expert immediately recognizes how homogeneous the mass spread onto the foil is (above right). Because lignin is a natural product, the brown coloring varies depending on the origin of the raw material.



LIGNIN

Wood (Lat.: lignum) consists primarily of cellulose, hemicellulose, and lignin. From a chemical perspective, lignins form a group of phenolic macromolecules that are embedded in the plant cell wall, and as a result cause lignification. Roughly 20 to 30 percent of the dry matter in woody rooted plants consists of the brown material. After cellulose, it represents the second-most common organic material on earth. Lignin is undesirable in paper production because it causes yellowing. Therefore, it has to be extracted from the wood, which requires a great deal of effort. Worldwide, around 50 million tons accrue per year as a waste product of the paper industry. Lignins, in the form of straw, saw dust and fermentation residues, are also recovered and burned en masse to generate electricity. In some cases, lignin already gets the chance to pass through a second “life cycle” as a binding agent in the cattle feed industry or as a base material for vanillin.

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