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1 *Linseed. (© iStockphoto)*
2 *Castor-oil-plant. (© iStockphoto)*
3 *Wood and lignin as a raw material. (© iStockphoto)*

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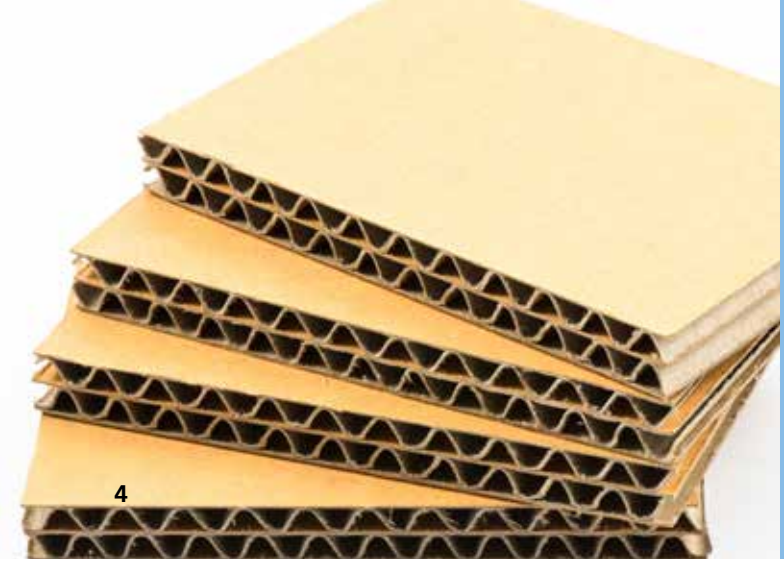
GREEN POLYMERS FROM RENEWABLE RAW MATERIALS

Status quo

The use of petrochemical or environmentally harmful raw materials for manufacturing chemicals and intermediate products is not simply a cost factor but also has a negative impact on the life cycle assessment. The efficient use of resources and the environmental compatibility of products, as indicated for example by the CO_2 footprint, are becoming ever more important for industry. Furthermore, consumers are all too aware of the finiteness of fossil resources and there is growing appreciation for products made from renewable raw materials.

Trend

The development of polymers made from up to 100% renewable raw materials, or raw materials recovered in a sustainable way, is already underway, with these materials being used for diverse applications including adhesives, sealants, coatings, and composites. Ongoing development work is endeavoring to replace petrochemical-based raw materials in a whole range of products, ranging from resin matrices to catalysts. Besides the growing demand for biobased raw materials, the recycling of renewable raw materials is also increasing in importance.



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Development work based on renewable raw materials

Starch-based adhesives

Starch is a renewable raw material and has long been used for manufacturing adhesives. Starch-based adhesives are nowadays mainly used for bonding paper and for manufacturing paper bags. To make starch-based adhesives, natural starch is first solubilized and modified in industrial processes. Fraunhofer IFAM is currently exploring using starch-based adhesives for other areas of application such as for bonding wood. Another application is for borax-free corrugated board production. Under the REACH regulation borax is classified as a CMR (carcinogenic, mutagenic, or reprotoxic) substance and is hence "a substance of very high concern". By identifying and testing alternative crosslinking systems it has been possible to implement the industrial manufacture of innovative borax-free Stein Hall adhesives.

Lactose, hydroxyalkanoate, and epoxidized oil as raw materials for adhesives and casting compounds

Lactose, hydroxyalkanoate, and epoxidized oil are classical raw materials which are suitable for use as an adhesive resin. Fraunhofer IFAM has investigated the relationship between the structures of these molecules, the morphology of the polymer, and the mechanical properties of the adhesive, so laying the basis for developing new products for other applications. Currently the casting compounds used for electrical and electronic components are mostly polyurethane-based materials. Some of these systems already contain considerable amounts of biobased materials, for example in the form of hydroxylated oils. Increasing the use of biobased materials further and developing systems which do not contain toxicologically harmful isocyanates, are the topics of ongoing R&D work at Fraunhofer IFAM.

Treatment of lignin for use as a raw material

Lignin is an aromatic polymer which gives plants their strength. It has a complex chemical structure and must first be modified before it can be used for technical applications. This involves a combination of chemoenzymatic and chemomicrobial processes. By transforming standard lignin raw materials in this way the lignin can be used in a wide variety of products. The controlled depolymerization at Fraunhofer IFAM enables, for example, the lignin to be used as a primer in adhesives and coatings.

Formaldehyde-free stoving enamels based on glycolaldehyde

The use of amino resins as crosslinking components and as the sole binder in stoving enamels guarantees high resistance to yellowing and excellent chemical, thermal, and mechanical stability. Currently amino resins are, however, based on formaldehyde which is classified as carcinogenic and mutagenic under the CLP (Classification, Labeling and Packaging) regulation. Glycolaldehyde is being investigated as a replacement for amino resins: Glycolaldehyde is a naturally occurring substance in many metabolic processes and possesses no toxic properties.

Chitosan as a coating additive

The polysaccharide chitosan is manufactured from the chitin of crustaceans. Due to its chemical stucture it has antimicrobial and hemostatic properties and forms hydrogels. Fraunhofer IFAM is endeavoring to utilize these attributes of chitosan for technical applications. One particular area being investigated is its use in antifouling coatings.

Composites and fiber reinforced materials

Fraunhofer IFAM is exploring the use of polymer blends, and natural fibers as fillers, for the manufacture of biocomposites made from environmentally friendly and totally degradable raw materials. The products have potential application, for example, in the packaging industry and in agriculture.

Range of services offered by Fraunhofer IFAM

- Development of new raw materials and formulations
- Optimization of existing formulations to meet your specifications
- Market research for raw material availability and potential customers/ markets
- Determination of typical physiochemical properties of the polymers

4 *Starch adhesives for the corrugated paper board production. (© iStockphoto)*

5 *Ligninbased binder for paints.*