Biodegradable film made of BioFlex protects banana trees from pests and environmental influences

For the Sake of the Environment

Biodegradable Film. Renewable raw materials are of particular interest for the production of biodegradable plastics if the property profile of conventional plastics can be properly simulated. Films of polylactide copolyester blends and cellulose blends are able to meet this challenge. Initial successes are also becoming apparent in the development of biodegradable self-adhesive tape.

During the oil crisis at the beginning of the 1970s, growing environmental awareness and the need to conserve resources led to a first wave of projects involving the development of products from renewable raw materials. These products were to have the same application and processing properties as conventional plastics but also be biodegradable.

Renewable raw materials are defined as materials that stem from living matter and are used by mankind specifically for purposes other than for food and feedstuffs. Biodegradable materials are materials that can be broken down by microorganisms or higher organisms.

Through the use of biodegradable materials from renewable raw materials, it is possible – in contrast to synthetic plastics – to achieve a natural material cycle. There are, however, other advantages as well:

- Renewable raw materials are largely CO_2-neutral. Their use does not cause any additional greenhouse effect.
- Natural resources like crude oil, which are not available in unlimited quantities, are conserved. Biomass, on the other hand, is inexhaustible because it grows again.
- Economic use can be made of overcapacities in agriculture, which also makes ecological sense. In this way, jobs can be preserved and even created in rural areas.
- Forestry and agriculture acquire alternative possibilities for production and income through renewable raw materials.

Biodegradable Polymers

Biodegradable polymers can be produced from both fossil raw materials and renewable raw materials. In the latter case, a distinction is made between raw materials of vegetable, microorganic (fermentative) and animal origin (Fig. 1).

Products made of these materials have become virtually indispensable in many areas of everyday life. Especially in the packaging segment – which is particularly suitable for biodegradable materials because of its short life – a whole range of interesting applications exists, e.g. packaging film, chips/loose fill, trays for fruit, vegetables, meat and eggs, cups, beakers, bottles, nets, bags, sacks, carrier bags, blis-

Name	Formulation
V1	Matrix copolyester/PLA in ratio 34/66
V2	Matrix copolyester/PLA in ratio 44/56
V3	Matrix cellulose acetate (CA)

Table 1. Composition of the test formulations

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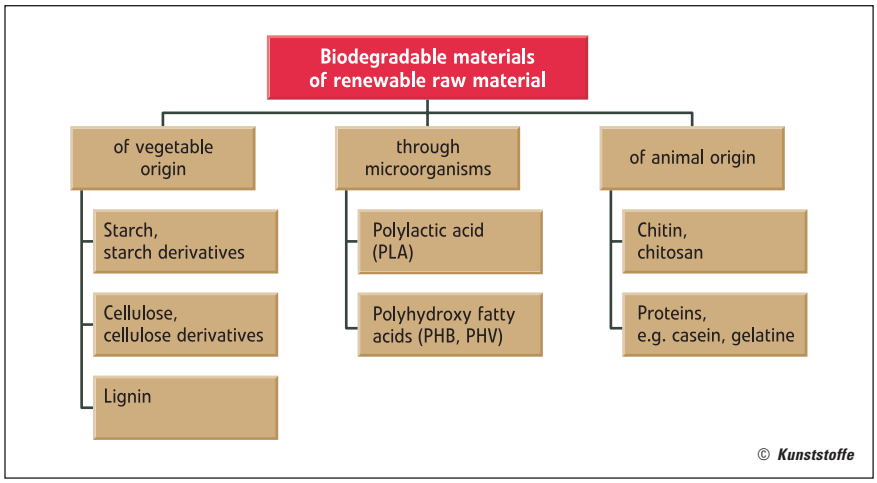

Fig. 1. Classification of biodegradable materials made of renewable raw materials

ter and skin packs, composite film and paper/cardboard coatings and composites. Another large market for biodegradable materials is agriculture with products such as agricultural film (title picture), plant pots and trays.

This article focuses on two examples of biodegradable polymers. They stem from a joint development project between the Fraunhofer Umsicht and FKuR Kunststoff GmbH. FKuR Kunststoff GmbH is responsible for the production and marketing side of the project.

Bio-Flex 219F Polylactide Copolyester

In developing the Bio-Flex 219F compound, the main objective was to create a product that has properties comparable with those of an PE-LD film (low-density polyethylene). Another important goal was that it should be able to run on conventional blow-moulding machines without problem. By the end of 2002, both challenges had been mastered. As Fig. 2 shows, the mechanical properties of Bio-Flex 219F are, as intended, similar to those of PE-LD. Comprehensive pilot trials and small production runs also showed that the material can be processed on conventional PE-LD blown film units without the need for any complicated modification of the screws, dies or take-off devices.

The good processing properties of this blend are attributable to the improved compatibility of the polymer components. Generally speaking, the blend components – polylactic acid (PLA) and copolyester – are incompatible, as is evidenced among other things by the delamination of the two materials when subjected to heavy shear stress. The addition of an innovative combination of compatibilisers helps the PLA establish a stable link to the copolyester. As a result, the proportion of PLA can be increased

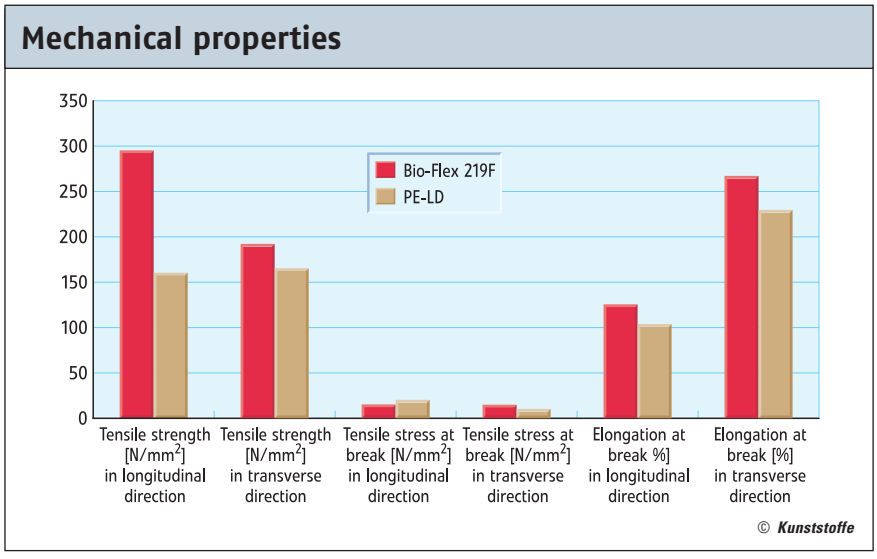

Fig. 2. Comparison of properties of Bio-Flex and PE

to a previously unknown level. In addition, the incorporation of natural inorganic fillers into the matrix (PLA/copolyester) is significantly improved.

Since the polymer compound is perfectly homogeneous, a film produced from Bio-Flex can be stretched by blown film extrusion down to a gauge of 8 µm. Compared with straight biodegradable polyester films or biodegradable polyester films filled with thermoplastic starch, the tactile properties are also improved. The material is compostable according to DIN EN 13432, which means that, up to a wall thickness of 110 µm, the film decomposes to a level of 90 % in compost after 12 weeks. Bio-Flex 219F is registered as a degradable material with DIN Certco (7W0042), while Bio-Flex films are certified as biodegradable (7P0073). The material is also certified for food contact applications.

Biograde 200C Cellulose Blend

Another biodegradable plastic is the transparent Biograde 200C. The particular advantage of this cellulose-based product is its unproblematical processing on conventional flat film units. Complicated modifications to screws, dies or take-off units are not needed here either. The production of injection moulding products on conventional injection moulding machines can also be carried out without problem.

Films or moulded parts made of Biograde 200C are noted for their high stiffness and brilliant transparency. The films can be readily thermoformed into cups and trays. Compared with former biopolymers, film produced from Biograde 200C has particularly good barrier properties. Basically, the properties of the Biograde films correspond to those of polypropylene films, although the injection-moulded Biograde products have a similar property profile to standard polystyrene, yet Biograde 200C consists entirely of renewable raw materials.

Biodegradable Adhesive Tape

Fraunhofer Umsicht and Logo tape Gesellschaft für Selbstklebebänder mbH & Co. KG are currently working on a research project involving the development of a self-adhesive tape based on renewable raw materials. In an ideal case, both the carrier film and the adhesive of the self-adhesive tape should be compostable in line with DIN EN 13432. The desired property profile of the new tape is governed by that of conventional self-adhe-

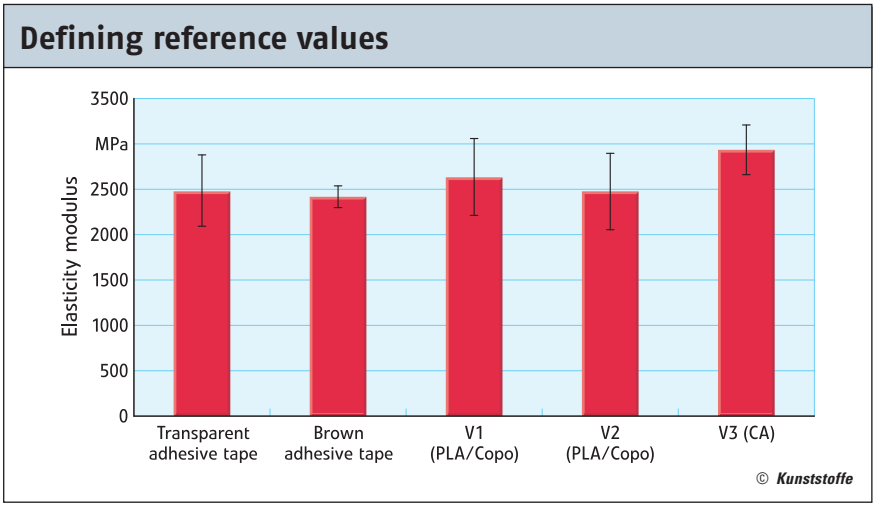

Fig. 3. Comparison of the elasticity modulus of reference adhesive tapes and test films of equal thickness made of PLA/copolyester and cellulose acetate

sive tapes in terms of the mechanical properties, initial adhesive strength, internal strength, shelf life and printability, and the aim was to match these properties without making any compromises. It turned out to be a major development challenge, which inevitably resulted in a conflict between compostability and the specified properties during the tape's service life.

To examine the quality characteristics, reference values were determined on various conventional self-adhesive tapes and compared with the mechanical properties of the test films (Figs. 3 and 4). For this comparison, the test formulations listed in Table 1 were used.

As Fig. 3 shows, the two selected PLA/copolyester blends have a similar elasticity modulus to that of the two standard self-adhesive tapes. The elasticity modulus measured for the cellulose acetate (CA) blend is well above that of the standard self-adhesive tapes. The PLA/copolyester test formulation V1 is comparable to the transparent standard adhesive tape in terms of both modulus of elasticity and the standard deviation in tensile stress at break and elongation at break (Fig. 4). PLA/copolyester test formulation V2 has a virtually identical elasticity modulus, tensile stress at break and elongation at break to the brown adhesive tape, while cellulose acetate blend V3 has far higher strength data than the other test blends or reference tapes and is additionally colourless and transparent.

Success Criteria

Renewable raw materials clearly have potential as raw materials for plastics. However, to be eligible, they must satisfy the following basic conditions:

- The cost of biodegradable plastics based on renewable raw materials must be competitive with that of petrochemical-based plastics. Exemption from the license fees of the "Duales System Deutschland", which is part of the new packaging regulations, supports this development.
- Acceptance among converters and their customers must be increased. This means it must be possible to process biodegradable plastics on conventional machines without any additional complications.
- Biodegradable plastics based on renewable raw materials must be further developed to permit their use in a wider field of application. For example, their barrier properties should be improved. ■

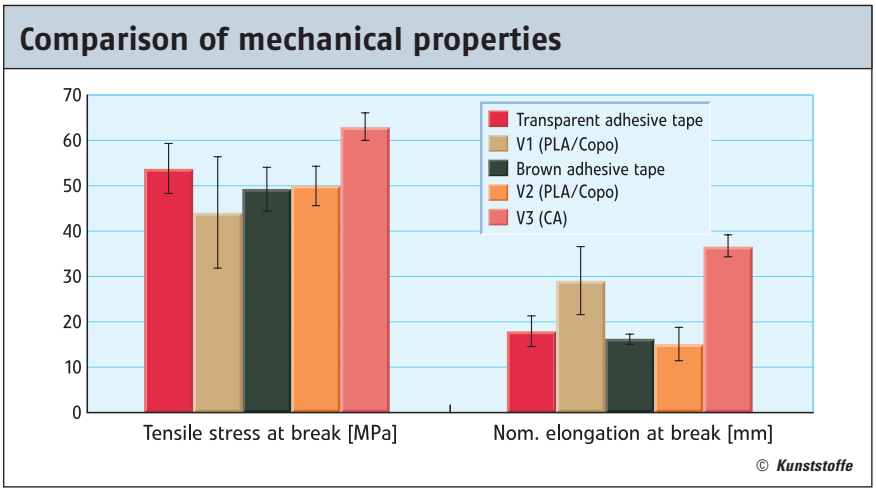

Fig. 4. Comparison of the mechanical data of reference adhesive tapes and test films of equal thickness made of PLA/copolyester and cellulose acetate

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