Sustainable Bioplastics 2016 - PBAT-A versatile material for biodegradable and compostable packagings - Maximilian Lackner-UniversityofAppliedSciencesFHTechnikumWien

Maximilian Lackner
UniversityofAppliedSciencesFHTechnikumWien,Austria

Despite the deep characteristics of polylactide (PLA), such as its origin in biomass and its biodegradability, PLA has several drawbacks that limit its use in different applications. A number of these drawbacks could be in accordance with its glass transition temperature (Tg = around 60oC) and its very slow crystallization kinetics. In applications where the service temperature requires to be below 60oC, the PLA behaves sort of a very fragile polymer, while in those cases where the service temperature must be much wider than more than 60oC, the heat can easily deflect the PLA because the degree of crystallinity is not high enough. to provide the required stiffness. Furthermore, a series of drawbacks arise from the melting conditions of the PLA. Due to the low resistance of the PLA melt followed by its low crystallization rate, forming the final products into the required shape is not easy. A similar scenario exists in the processing of the PLA / gas mixture to form high quality foamed structures. In this work, it's shown that improving the crystallization kinetics of PLA could significantly improve its processability, formability and foamability, and will extend its service temperature beyond its Tg, and also can improve the mechanical properties of its final products. . Furthermore, mixing PLA with other biopolymers with high melt strength, high toughness and ductility could improve the melt strength and processability of PLA, catch up on its brittleness, and improve its mechanical properties. These approaches provide new routes to expand the use of PLA in much broader commodity applications.

PLA can degrade into harmless lactic acid, so it is used as medical implants in the form of anchors, screws, plates, pins, rods and as a mesh. Depending on the precise type used, it breaks down within the body within 6 months to 2 years. This gradual degradation is desirable for a support structure, because it gradually transfers the load to the body (eg, bone) as that area heals. The strength characteristics of PLA and PLLA implants are well documented. PLA can also be used as a decomposable packaging material, whether cast, injection molded or spun. Cups and bags are made up of this material. In film form, it shrinks when heated, allowing it to be used in shrink tunnels. It is useful for producing loose containers, compost bags, food containers, and disposable tableware. In the sort of fibers and non-woven fabrics, PLA also has many potential uses, for instance upholstery, disposable garments, awnings, feminine hygiene products, and diapers. Thanks to its biocompatibility and biodegradability, PLA has also found wide interest as a polymeric framework for drug delivery purposes.

Racemic and regular PLLA features a low glass transition temperature, which is undesirable. A stereo complex of PDLA and PLLA has higher glass transition temperatures, giving it more mechanical strength. It has a good range of applications, like woven shirts (ironability), microwave trays, hot fill applications, and even engineering plastics (in this case, the complex stereo is mixed with a rubber-like polymer like ABS). Such blends also have good shape stability and visual transparency, making them useful for low-end packaging applications. Pure Poly-L-Lactic Acid (PLLA), on the opposite hand, is that the main ingredient in Sculptra, a long-lasting facial volume enhancer, used primarily to treat lipoatrophy of the cheeks. Progress in biotechnology has resulted within the development of economic production of the D-enantiomer form, something that wasn't possible until recently.The monomer is usually made up of starch from fermented plants, such as corn, cassava, sugar cane or sugar beet pulp.
Several industrial routes allow usable (i.e. high molecular weight) PLA. Two main monomers are used: lactic acid and cyclic diester, lactide. The most common route for PLA is the ring-opening polymerization of lactide with various metal catalysts (typically tin octoate) in solution or as suspension. The metal catalyzed reaction tends to cause racemization of PLA, reducing its stereoregularity compared to the starting material (generally corn starch).
PLA polymers range from amorphous glassy polymers to highly crystalline, semi-crystalline polymers with a glass transition of 60–65 ° C, a melting temperature of 130-180 ° C, and a tensile modulus of 2.7–16 GPa. Heat resistant PLA can withstand temperatures of 110 ° C. The basic mechanical properties of PLA are between that of polystyrene and PET. PLLA's melting temperature can be increased by 40–50 ° C and its thermal deflection temperature can be increased from approximately 60 ° C to 190 ° C by physically mixing the polymer with PDLA (poly-D-lactide). PDLA and PLLA form a highly regular stereocomplex with higher crystallinity. Temperature stability is maximized when a 1: 1 mixture is used, but even at lower concentrations of 3 to 10% PDLA, there is still a substantial improvement. In the latter case, PDLA acts as a nucleating agent, thereby increasing the rate of crystallization [citation needed]. Biodegradation of PDLA is slower than for PLA thanks to the upper crystallinity of PDLA [citation needed]. The flex modulus of PLA is higher than polystyrene and PLA has good heat sealing ability.

Biography:

Dr. Maximilian Lackner earned his PhD in 2003 and his habilitation in 2009 from Vienna University of Technology. He has held several senior leadership positions in the polymer industry in Austria and China. Dr. Lackner has founded 5 companies, amongst them one for antimicrobial polymers and one in the area of bioplastics, Lackner Ventures & Consulting GmbH. This company collaborates with JinHuiZhaolong, one of the largest PBAT manufacturers. The research interests of Dr. Lackner include PHA and PBAT. Lackner Ventures & Consulting GmbH runs a research project to produce PHB from CO2 and sunlight using cyanobacteria. Dr. Lackner has authored more than 100 scientific articles. He teaches materials science at the University of Applied Sciences FH Technikum Wien.

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