

Poly (Lactic Acid): Green and Sustainable Plastics

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Editorial

Poly (lactic acid) (PLA) is one of the most versatile environment-friendly biodegradable thermoplastic polyester. It is linear aliphatic thermoplastic polyester derived from 100% green and renewable sources such as corn (Figure 1). PLA has wide range of properties such as bio-compatibility, bio-degradability, less toxicity, vast range of mechanical properties and the ability to be molded into different shapes. These properties make it a very suitable material for applications similar to plastics and more widely in biomedical fields [1]. Low molecular weight PLA was produced by Carother et al. in 1932. The first marketing of PLA for medical purpose was initiated by E. I.



Figure 1: PLA green cycle in nature

Du Pont de Nemours and Ethicon, Inc. in 1954. The development in the field of PLA first started in 1983 with publication of production formulas of lactide by Bichoff and Walden. A Japanese industry, Shimadzu Corporation and Kanebo Goshen Ltd. Started commercial production of PLA in 1994 by fiber and melt spinning and sold it under trade name lactron. France started producing PLA under trade name Deposa in 1997. Cargill and Dow were first to produce PLA in large scale in USA under joint venture named Nature Work LLC. In 2009 nature work was completely owned by Cargill. At present time, many countries like Switzerland, China, and Korea are taking initiative in the production of PLA. PLA is produced from lactic acid (LA) monomer. In 1895 lactic acid was first produced commercially in Germany under pharmacy Boehringer Ingelheim [2]. LA monomer was approved as food additive by the FDA. This makes PLA a unique green polymer that has low toxicity in addition to comparable performance to petroleum-based plastics. Various research and studies are being carried out around the world on PLA and PLA has proved

itself to be very promising material in field of bone fixation, drug delivery vehicle, tissue engineering, scaffold and various other biomedical applications [3].

Thermal processing of PLA is much easier compared to other biopolymers. However, PLA possess some demerits like poor toughness (it is very brittle and possess very poor tensile strength), slow biodegradability, hydrophobicity and lack of reactive side chains. There are various factors that affect biodegradability of PLA, which generally takes place by hydrolysis of ester group. Some of these factors are diffusion of water on PLA, homogeneity of weight distribution and isomeric content. This feature of biodegradability of PLA allows for applications as scaffolds to regenerate damaged tissues. PLA scaffold application varies from load bearing region to tensile force bearing region. The property of fabricated scaffold should be complimentary to its area of application. Different modification methods of scaffold could be juggled to achieve the product accordance to area of application. Although PLA possess some shortcomings which acts as obstacle in it efficient use as bone scaffold, it can be easily overcome by bulk and surface modification. There many ways to improve the properties of PLA, the most common way is to blend PLA with other materials to enhance its properties. Although different material adds different properties to PLA scaffold, all of these methods are flawed at some level. For example porosity, hydrophilicity, and bio-conductivity helps in cell growth and cell adhesion but might compromise scaffold strength. Similarly in case of surface modification process, a single plasma treatment can merely improve cell adhesion but cannot accelerate cell growth; non-covalent attachment of a functional material onto a PLA surface is not stable and permanent. It appears that the surface modification of PLA would be best achieved with a combination of distinct approaches, to benefit from the advantages of all the methods [3].

At the end, the question remains whether more advancement in the production of PLA will bring it to the market at lower price that makes it the future green plastics. The green polymer can replace wide range of petroleum-based plastics while maintain the advantage of being biodegradable and less toxic.

References

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