Retraction

Retraction: PLA based Bio Composite reinforced with natural fibers – Review (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012069)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

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IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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PLA based Bio Composite reinforced with natural fibers—Review

A Felix Sahayaraj¹, M Muthukrishnan¹, R Prem Kumar¹, M Ramesh¹ and M Kannan¹

¹Department of Mechanical Engineering, Kalaignar Karunanidhi Institute of Technology, Coimbatore, India.
go2feli@gmail.com

Abstract. Now-a-days the production of polymers reinforced with natural fiber has rapid growth, the reason behind this growth is the properties and performance of the natural plant fiber reinforced composites are superior to conventional polymers derived from petroleum. Due to its biodegradability nature researchers and industries shows tremendous interest in the field of poly lactic acid (PLA) based biopolymers. Even though due to its Brittle nature and high production cost, restrict their use in broad various application. For those reasons material scientists carried out various researches to enhance the properties of PLA by reinforcing with different materials. Various researches show that reinforcing with biodegradable products to make cost effective product and reducing the brittle nature of PLA by making bio composite. When compare to synthetic fibers have less expensive, high strength to weight ratio, ease to handle. Even though it has some disadvantages such as water absorbance and hydrophobicity problem. It is also mandatory that changing the surface behavior for even stress distribution between fiber and matrix.

1. Introduction
The petroleum-based polymer composites will take more years to degrade has bad impact on the Environment and climate. Due to this concern product manufacturers to looking for potential alternatives such as eco-friendly composites for their goods and products. Bio composites consisting of natural fibers as reinforcing element with biodegradable matrix, is a green product derived from natural resources, have very good life, and completely biodegradable after use. They are less toxic, easy to fabricate, having very good strength to weight ratio as well they can be for reducing the carbon footprints. For this cause, the bio fiber reinforced polymers has rapid production growth in past decades, particularly in the food packaging and medical industries. The composites reinforced with natural fiber are biodegradable, recyclable, will replace the petroleum based polymer composites [1].Bio fibers based composites with Poly lactic acid (PLA) as a matrix substance are commonly used in automotive applications [2]. Apart from the automotive application, the Poly lactic acid (PLA) based bio composites can be used in building materials, consumer products, medical industries and aerospace applications [3].These fibrous bio composites having very good thermo-mechanical properties and can be act as biomaterials for wide variety of applications in the field of medical implants [4].Even though Poly lactic acid (PLA) have some drawbacks, such as brittleness behavior, low impact strength and hydrophobicity [5], can be enhanced by fibers or fillers [6].This study is aimed to provide summary of various kind of natural plant fibers and check whether its suitable to use as reinforcement of filler.
2. Poly lactic acid (PLA)
PLA is a type of polymer which is fermented from the corn starch with the formula of \((\text{C}_3\text{H}_4\text{O}_2)_n\), and consumption of PLA is second largest bioplastic in the world. It is fermented from the natural resources especially corn starch and cassava starch. The Fig.1. Shows that, PLA can be manufactured or processed by direct condensation polymerization or ring opening polymerization. High molecular weight polymers are not compatible with direct polymerisation process, the reason is water is formed as undesirable co-product during the fermentation which can reduce the properties of the polymer [7-9]. Due to its beautiful mechanical and physical behaviors such as high modulus, strong and rigidity this will be probable alternative for the synthetic polymers such as polyethylene (PE), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET) [10]. Poly lactic acid (PLA) melting point is in the range of 160 to 175°C which is very good suitable for food packaging, construction and automotive industries. Poly lactic acid (PLA) mechanical properties are better than the conventional polymers such as PET [11]. Moreover, this PLA can be used as biomaterial due to its biodegradability, non-toxicity and bio compatibility. It can be used in medical application like scaffold, drug delivery and tissue engineering [12-14]. Even though it has some major drawbacks such as low toughness and high production cost. In order to overcome this drawback so many researches carried out with natural fiber as reinforcing element in the Poly lactic acid (PLA) matrix [15]. Figure 1 shows the Synthetization of Poly lactic acid by direct condensation and ring opening approach.

![Figure 1](image.png)

*Figure 1. Synthetization of Poly lactic acid by direct condensation and ring opening approach.*

3. Reinforcement Materials

3.1. Classification of composites
The composite materials are categorized into mainly three types based on the matrix type like polymer matrix, metal matrix as well ceramic matrix composites as shown in Figure 2 (a). Depending upon the reinforcement three different types of composites are categorized as particulate composites, fiber composites and structural composites. The classification is shown in the Figure 2 (b).
3.2. Natural fiber
Natural fibers, due to their flexibility, less expensive, recyclability, local availability compared to petroleum based fibers, are the best alternative materials. The reinforcement of natural plant fibers with polymer matrix having wide application in various type of industries. The fibers can be extracted from various sources like stem, leaf, seed etc. The natural fibers can be classified into several groups for example stem fiber, leaf based fiber, seed based, fruit based fiber stalk based fiber, grass based fiber and wood based fiber depending on the part which they extracted from the natural plants these classifications were shown in Figure 3.
3.3. Chemical Composition

Cellulose is the building block of fibrous cell having high strength and very good weight. Such cells can be located in various plant parts such as stem, leaves, seed and fruits. The chemical composition of fiber varies for different kind of fibers. Moreover, major elements of bio-fibers are Cellulose, hemicellulose, and lignin in which cellulose act as skeleton of fiber. The chemical composition of the various natural plant fibers was shown in Table 1.

| Fiber | Cellulose (%) | Hemicellulose (%) | Lignin (%) |
|-------|---------------|-------------------|------------|
| Bamboo | 73-83         | 10-15             | 3.16       |
| Banana | 63-68         | 5-10              | 4.6        |
| Flax   | 71-78         | 2.2               | 1.5-3.3    |
| Hemp   | 70.2-74.4     | 3.7-5.7           | 0.9-1.7    |
| Jute   | 61-71         | 12-13             | 0.7        |
| Kenaf  | 45-57         | 8-13              | -          |

3.4. Natural fiber Properties

Plant fibers are generally fibrous in nature and also, they have very good thermal as well as sound insulation behavior. When compare with synthetic fibers these bio-fibers are lower in mechanical properties, but by enhancing the strength of these fibers can result in equal or superior properties than the petroleum based synthetic fibers. These bio-fibers get very good attention from the companies because of its low density, less expensive behavior.

The Table 2 which display the various mechanical properties of natural fibers. The Table properties clarify that young’s modulus is very similar to both bio-fiber and synthetic fiber. The tensile strength is synthetic fiber tensile strength is stronger when compared to the natural fiber, but other properties of very similar to bio-fiber.

| Fiber  | Density (g/cm3) | Tensile Strength(MPa) | Young’s Modulus(GPa) | Elongation (%) |
|--------|-----------------|------------------------|----------------------|---------------|
| Cotton | 1.6             | 286-597                | 6-12                 | 3-10          |
| Banana | 1.35            | 355                    | 33.8                 | 5.3           |
| Flax   | 1.5             | 750-1500               | 80                   | 2.5-3.2       |
| Hemp   | 1.4             | 500-900                | 40-70                | 1-4           |
| Jute   | 1.48            | 390-800                | 13-26                | 1.4-1.8       |
| Kenaf  | 1.56            | 350-900                | 42-53                | 2-6.9         |

3.5. Chemical Treatment of Natural Fiber

Various researches carried out to increase the adhesion strength between the polymer matrix and natural fiber reinforcement in order to achieve the better mechanical and wear behavior. Due to hydrophilic problem, adhesion strength between the matrix and reinforcement is reduced considerably. With the purpose of achieve the optimal properties various experiments conducted on the surface of
the bio-fiber. The poor bonding strength between matrix and fiber resulting in decreased mechanical properties. The reason behind the poor bonding strength is bio-fibers hydrophilic nature of polymer matrix. In order to overcome these problem it is necessary to do some treatment on bio-fibers. Chemical, physical and biological treatment on bio-fiber used to minimize the hydrophilicity and removing the moisture from the fiber surface.

4. Conclusion
This current research was focused on investigating that whether the PLA suitable as a polymer matrix in the composites where natural fibers are reinforced. The research work carried out by the scientists reported that composites which reinforced by natural fiber are equal or superior to the synthetic fiber composites. Various types, properties as well application of natural-fibers have been discussed and they the very good potential to replace conventional synthetic fibers which are refined from the petroleum. In order to fully understand the properties and behaviour of Poly lactic acid and natural fiber reinforced Poly lactic acid (PLA) composites and its processing route, performances under various processing parameters, detailed research study was done.

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