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The Development of Renewable Energy Sources and Its Application in the Industrial Field

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Abstract:

Fossil fuels such as coal, oil, and gas are non-renewable resources that take millions of years to form, making the shift to renewable resources essential. This paper discusses the application advantages and development status of two key renewable materials: Polylactic Acid (PLA) and Polyhydroxyalkanoates (PHA). PLA, a biodegradable polyester derived from lactic acid, and PHA, a natural polymer synthesized by microorganisms, offer promising alternatives to petroleum-based plastics. Their use in packaging, textiles, and medical fields helps reduce fossil fuel reliance and promotes the growth of renewable energy sources. They have been widely applied in different fields. They have been widely used for packaging material, including packages for food, delivery service, and so on. PLA and PHA can grow together to meet the different needs of society while protecting the planet's environment. This paper aims to reduce dependence on fossil fuels and promote the development of renewable energy, thereby promoting sustainable development and environmental protection. Overall, the study highlights that the co-development of PLA and PHA can meet social needs and help protect the earth's environment.

Keywords: PLA; PHA; environment.

1. Introduction

As the global economy continues to grow, energy demand continues to rise, and at the same time, environmental pollution and climate change are becoming increasingly serious. The consumption of fossil fuels leads to the emission of large amounts of greenhouse gases, such as carbon dioxide and methane, which in turn exacerbate the rise in global temperatures, causing serious harm to the environment. At the same time, the depletion of traditional fossil fuels is driving us to seek more sustainable energy sources. Because of all these types of global issues, one of the solutions is to explore and utilize renewable resources.

Energy derived from natural resources that replenish more quickly than it is consumed is known as renewable energy. Examples of such sources that are continuously replenished are sunlight and wind. There is a plentiful supply of renewable energy around us. In contrast, non-renewable resources such as coal, oil, and natural gas require hundreds of millions of years to create. The development of renewable resources would be required.

Currently, the representative materials for renewable resources are PLA and PHA. Polylactic Acid (PLA) and Polyhydroxyalkanoates (PHA) can serve as alternatives to petroleum-based plastics, with applications in packaging, textiles, and the medical field that helps reduce fossil fuel consumption and support renewable energy growth. PLA is a biodegradable polyester derived from lactic acid, while PHA are natural polymer synthesized by microorganisms. Currently, researchers have been conducting various studies on Polylactic Acid, such as the study of its biodegrading ability(which explores the degradation behaviour of Polylactic Acid under different environmental conditions), and its performance optimization[1]. Polyhydroxyalkanoates (PHA) are natural polymer-based materials synthesized by microorganisms, which are used as microbial carbon sources and energy reserves. At present, there are more than 150 monomer species of PHA, resulting in a wide variety of PHA varieties and different material properties. PHA has the characteristics of material variability, nonlinear optical properties, piezoelectric properties, gas barrier properties, thermoplasticity, biodegradability, good biocompatibility, etc., which makes it have great application prospects in many fields such as plastic packaging, chemical industry, medicine, agriculture, and bioenergy.

Both of them have been used in a lot of inventions that are pervasive and utilitarian in people's daily lives. For example, they have been widely used for packaging material, including packages for food, delivery service, and so on. They have also been used for industrial purposes. 3D printing uses this material in order to be low-cost and ease of use. Other places that use these materials include construction of building, medical field, and textiles.

This context will focus on discussing the renewable resources: Polylactic Acid(PLA) and polyhydroxyalkanoates(PHA), including their advantages and disadvantages, and their application in society: where and how are they applied?

2. Biomanufacturing

To reduce the use of petroleum-based plastics and avoid causing more white pollution, researchers have been looking for degradable alternative materials. Biomanufacturing is one of the recognized alternative material production paths [2]. Polylactic acid is a polymer derived from renewable resources, mainly through sugar-rich plants such as corn starch, sugarcane or sugar beet, which is converted into lactic acid through microbial fermentation process, and then chemically synthesized. The emergence of this bio-based material marks a major step towards sustainable development in the field of materials science. As a renewable resource, PLA has several advantages besides that it is made from renewable raw material. PLA is easier to melt because it has a lower melting point than many fossil-based plastics [3]. It's easy to use PLA and requires less energy to convert; Also, Lactic acid (LA) monomer can be extracted from crops such as corn and potatoes. It has the characteristic of recirculating lactic acid through degradation, photosynthesis and other processes[4]; Polylactic Acid has good tensile strength degree, Young's modulus, flexural strength, its tensile strength and elastic modulus; also, PLA is compostable. When PLA is incinerated, it releases less toxic fumes than petroleum-based plastics[5].

However, it still has a bunch of disadvantages. PLA, while biodegradable and eco-friendly, is more expensive than fossil-based plastics. Its low melting point limits its use in high-temperature environments, and it may soften or deform in hot conditions, such as during summer. Additionally, due to its insufficient hardness and toughness, PLA is unsuitable for applications that demand high-impact resistance and durability. Therefore, there is still a lot of effort needed in the study of PLA. Future research can focus on improving the thermal stability and toughness of PLA to expand its application range.

PHA is made by microorganisms through a process called polymerization. In this process, small molecules called monomers are bonded together to produce more complex chain-like structures called polymers. More than 150 PHA monomers have been reported to be monochiral R-type isomers, most of which are 3-hydroxylipids with a carbon chain length of 3–14 fatty acids (3HA), and some 4HA and 5HA. Composition of PHA. The differences in monomer composition and proportion give PHA a lot of physical and chemical properties. Diversification PHA has excellent thermoplastic processability, Biocompatible and biodegradable, recognized as green and environmentally friendly Polymer materials are receiving increasing attention. However, its hydrophobicity Strength, poor thermal stability, narrow processing window, high cost and other shortcomings.

3. Fields of application

As renewable resources, both PLA and PHA are widely applied in society. First of all, PLA is used in varies fields. In order to compensate for the brittle and non-biodegradable flaws in conventional mulch film, polylactic acid can be processed into agricultural mulch film due to its strong

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flexibility, heat resistance, and physical processing qualities. It can also be processed into accessories engineering materials in the automotive industry, construction ropes, pesticide and fertilizer slow-release materials, etc[6]. Also, PLA is widely used for food packaging materials. Rapid prototyping is one of the primary applications of PLA in 3D printing. It is perfect for rapidly and effectively producing prototypes because to its smooth surface and ease of printing. Without devoting a significant amount of time and resources to more costly materials or methods, designers and engineers can iterate and improve their concepts. Although PLA might not be the best option for functional testing in every scenario, it offers an affordable means of visualizing and assessing design concepts. PLA is a great material to use for building architectural models because of its dimensional stability, stiffness, and variety of colors. A building or structure's overall aesthetics, design components, and spatial relationships can all be seen and communicated with the use of these models. Furthermore, the biodegradable qualities of PLA in the production of single-use models that are only meant to be used temporarily is a more environmentally responsible solution.

Various PLA blends have been explored for biomedical applications such as drug delivery, implants, sutures, and tissue engineering[7]. PLA film is also widely used in the packaging of fruits and vegetables, baked goods, etc., with its good barrier and transparency, which not only keeps food fresh but also reduces plastic waste. From straws, and lunch boxes to tableware, PLA products have become the first choice for environmental protection upgrading in the catering industry with their safe, non-toxic and degradable characteristics, effectively alleviating the environmental pressure caused by plastic tableware.

PHA offers a wide range of application experience in medicinal, sustained-release, tissue engineering, electrical, and biodegradable packaging materials.

The advantage of PHA in the medical field is that it does not require a second pass of Surgical removal, e.g. PHB can be completely degraded into human blood 3HB of the normal component does not cause rejection or toxicity Sex. In 2007, absorbable sutures made from P4HB TephaFLEX were approved by the United States FDA as the first vendor of Quantified PHA medical products. Currently, PHA has been used for groups: Weaving engineering, implant materials, drug sustained release, medical care and other collars domain research[8]. The biodegradability of PHA, as well as its biocompatibility, make it an excellent choice for drug carriers. As a degradable carrier, PHA is used for the controllable release of drugs, hormones, pesticides and herbicides, which has attracted more and more attention from researchers. In general, drug micro-nano carriers are processed into micro/nano-sized particles, small molecules such as drugs are wrapped in nanoparticles or adsorbed on their surfaces, and specific targeted molecules, such as specific ligands and monoclonal antibodies, are coupled on the surface of the particles.

PHA also has a wide range of applications in the field of food packaging. It can replace traditional plastic packaging, reduce plastic pollution and protect the environment[9]. At the same time, the safety of PHA is also guaranteed, which can effectively protect food and improve food safety. With the advancement of technology, the production cost of PHA is expected to gradually decrease, further expanding its application prospects in the field of food packaging, and making greater contributions to food safety and environmental protection.

Moreover, PHA can be used as a graft for animal and human tissues to be implanted into the body as a scaffold for certain tissues. It can be made into bone nails, bone rods and other fixed skeleton materials in orthopaedic surgery, it has a reinforcing effect, the rough surface can promote the growth of human tissues, and its pores can be used for penetration and exchange when the new tissue grows, PHA is gradually degraded, and the decomposed products can be absorbed by the human body without causing adverse reactions[10].

PHA can also be used in high-value-added fields such as hygiene products, diapers, optically active materials, cosmetics, etc., and has a wide range of application prospects in spraying materials, clothing, and utensils.

4. Prospects and challenges

Conclusively, new resources like PLA and PHA have a promising future. PLA's heat and water tolerance need to be improved. Also, PLA's process of degrading is grossly impacted by the environment, so more focus is needed on studying its degrading mechanism. PLA still faces many technical and resource challenges in practical application. PLA mainly come from agricultural output like corn, so more land will be needed for farming, leading to potential threats to food resources. Moreover, conditions for the degradation of PLA include specific levels of temperature and humidity. Scientists have to find ways to improve the efficiency of degrading PLA in nature.

PHA's future developments are also imperative. PHA's heat tolerance requires continuous improvement, and the cost of PHA, which is currently expensive, needs to be reduced. There is also room for expanding the use of PHA into wider fields, such as electronic devices and mechanics. However, there are still several challenges that scientists have to conquer. One of them is the scale of production. Currently, the rate of production of PHA makes it hard to fulfil the demand for PHA in society. Also, innovations and newer technologies are required to achieve technological breakthroughs, in order to improve its quality and reduce its cost. Along with technological breakthroughs, extensive publicity is also crucial to raising consumer awareness of PHAs and their environmental benefits.

In the future, PLA and PHA can develop together, in order to fulfil different demands on society, and at the same time, protect the earth's environment.

5. Conclusion

This article mainly introduces the advantages and disadvantages of two renewable energy sources, PLA and PHA, and their applications in society. By examining the advantages and disadvantages of both PLA and PHA, the passage discussed the orientation of future improvement for PLA and PHA. The degradation process of PLA is seriously affected by the environment, so more attention needs to be paid to the study of its degradation mechanism. PLA still faces many technical and resource challenges in practical applications. The heat resistance of PHAs needs to be continuously improved, and the cost of today's expensive PHAs needs to be reduced. The use of PHAs has also expanded to a wider range of fields. As renewable resources, both PLA and PHA are widely applied in society. PLA and PHA have been applied in fields including packaging, biomedical, agriculture, consumer products, textiles, 3D printing, and so on. Their applications in these fields can help reduce the demand for fossil fuels and promote the development of renewable energy. All in all, new resources such as PLA and PHA are promising.

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