

New Functional Textiles from Bio-based and Degradable Fibres

新型生物可降解功能紡織品

The textile and clothing industry is seeking eco-friendly and sustainable solutions to the increasing energy demands of production and negative effects on the environment. PLA and PHBV are 100% bio-based, biodegradable, nontoxic and biocompatible polymers. Although having good spinnability, PLA has low heat resistance, high rigidity and brittleness after long-term storage. It is difficult to apply to textile processes such as yarn texturing, dyeing and finishing. PHBV is widely used in the production of plastic goods, but because of its poor spinnability and high brittleness, it is rarely used in the textile industry.

However, the blending of PHBV and PLA into textile fibres provides greater heat stability and softness than is the case with pure PLA fibres. This project successfully developed technologies for low temperature yarn texturing and low temp dyeing processes in shorter time for green textile products made from PHBV/PLA fibre.

紡織製衣業面對生產能源需求與日俱增，致力減輕生產對環境的影響，開發既環保又可持續發展的生產模式及產品。PLA及PHBV是百分百生物基、可降解、無毒、是具有生物相容性的聚合物。

雖然，PLA的可紡性甚高，但耐熱性偏低，經長時間儲存後會變硬和脆，難以應用於紗線變形、染色及整理加工等生產過程中。PHBV向來廣泛應用於生產各種塑膠製品，但由於其可紡性低，而且本質較脆，甚少用於生產紡織品。

不過，PHBV與PLA混紡而成的纖維耐熱度與柔軟度均較純PLA纖維為佳。這個項目利用PHBV-PLA混紡纖維成功研發出低溫紗線變形及染色技術，並製作環保紡織品。



Application 應用

- The dyeing process is optimised by identifying a set of optimal parameters, which include: dyeing temperature and time, pH values of the dye bath, and liquor ratio according to the specific properties of PLA/PHBV fabrics, such as glass transition temperature and fabric density. Disperse dyes possessing high energy levels were used since they have a close affinity to PLA and PHBV, which possess molecular structures of aliphatic polyesters. The results show that disperse orange 30, disperse red 74 and disperse blue 79 have excellent dyeing properties for PLA/PHBV fabrics.
- A pressure stocking was developed by using covering and modified false-twist texturing with elastic yarns of good quality to achieve accurate pressure distribution. The production method meets the industrial standard for the manufacture of stockings for varicose veins.
- The project was able to use thermoplastic PHBV materials for 3D printing.
- 項目開發出染色參數令染色效果更理想，當中包括浸染溫度、時間、染浴酸鹼值及浴比，這些參數會因應不同PLA/PHBV布料的特性而改變，例如布料纖維的玻璃化溫度或布料密度。是次研究採用高能分散染料，令染色效果更容易黏附於擁有脂肪族聚酯分子結構的PLA及PHBV纖維。研究結果顯示分散橙30、分散紅74、以及分散藍79的染色效果尤其理想。
- 通過採用包纏和改進的假撚變形方式及力學性能優異的彈力紗，可以有助更精確、合理計算壓力襪的壓力分佈，並達到製作治療靜脈曲張壓力襪的工業生產要求。
- 項目亦開發複雜多孔結構的柔性生物醫用材料的3D打印技術。

Industry Benefits 業界效益

- To obtain excellent dye exhaustion, the dye bath temperature of PLA/PHBV should be set between 90°C and 100°C, which compares favorably to the 130°C required for dyeing with PET. As such, PLA/PHBV dyeing is a low-energy process, yielding a 32% energy saving.
- The dyeing process has high dye take-up and a high exhaustion rate of residual dyestuff in waste water. The fabric's colour-fastness meets the industry standard. The method can be applied to the production of high quality PLA/PHBV knitwear which is thin, silk-like and soft to handle.
- The textile products have excellent mite-resistance, achieving the highest anti-mite rank: AA. The processes are applicable to medical textiles, home textiles and fashion items which require high standards of hygiene.
- A 3D fabrication technology was developed for biomaterial pseudo-textile structures. This improves production efficiency, and so decreases the cost of medical products created in vitro.
- 讓PLA/PHBV布料充分吸收染料，最理想的染浴溫度是攝氏90度至100度之間，比起染PET布料所需130度，染PLA/PHBV布料消耗較少能源，可節省三分之一能量。
- 這個染色過程具理想的上色率，減少廢水中的殘餘染料，布料的染色牢固度亦符合業界標準，適合生產纖薄、仿絲質地、柔軟的高質素PLA/PHBV針織品。
- 這類紡織品具理想的抗菌驅蟎性能，防塵蟎評級達最高的AA水平，適合應用於講求衛生的醫療紡織品、家居紡織品及時裝產品。
- 項目開發的3D生物材料偽紡織結構的加工技術有助降低外科醫療產品的生產成本，提高效率。

Technological Breakthrough 技術突破

- For the first time, PLA/PHBV fabrics and medical compression stockings were manufactured through industrial textile processes modified to handle unique fibres.
- PLA/PHBV fabrics have been shown to be naturally anti-bacterial against staphylococcus aureus, klebsiella pneumonia and candida albicans. No additional use of chemical agents is required.
- 針對PLA/PHBV纖維特殊性能運用改進後的工業用紡織工藝，首次成功生產出PHBV/PLA織物和醫用壓力襪。
- PLA/PHBV織物在無任何化學添加劑的條件下，對金黃色葡萄球菌、肺炎克雷伯桿菌和白色念珠菌具有天然抗菌性。

Licensing Details 獲取專利

A non-exclusive licence covers:

- spinning, knitting, dyeing and finishing of the PLA/PHBV yarn and fabrics;
- production technology of the compression stocking;
- 3D printing technology for the flexible biomedical materials with complex porous structures.

非獨家專利授權包括:

- PLA/PHBV的紡紗、針織、染色和後處理技術；
- 壓力襪的製作技術；
- 複雜多孔結構的柔性生物醫用材料的3D列印技術。



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