ACS GCI Green & Sustainable Chemistry Summer School

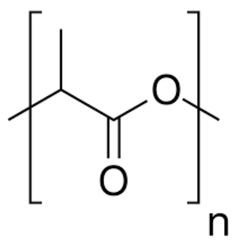
DEVELOPING FULLY BIO-BASED AND BIODEGRADABLE POLY (LACTIC ACID) BIOCOMPOSITES: LIGNOCELLULOSIC FIBER-REINFORCED FOR HIGH-PERFORMANCE APPLICATIONS

Giulia Herbst [a,*], Luiz Pereira Ramos [a], Marc Delgado-Aguilar [b], Marcos L. Corazza [a]

[a] Department of Chemical Engineering, Federal University of Paraná, Francisco H. Santos Av. 100, 81531-990 Curitiba, PR, Brazil;
[b] LEPAMAP-PRODIS research group, University of Girona, C/ Maria Aurèlia Capmany, 61, 17003 Girona, Spain.
*(*giuliaherbst@ufpr.br)*

Introduction

Poly (lactic acid)



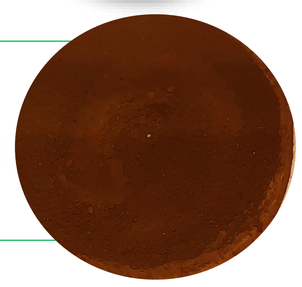
Objective

Elucidate the suitability of incorporating pine stone groundwood fibers (SGW), its fractionation cellulose fibers and lignin into PLA at different contents and evaluate the influence of silane as a coupling agent in the biocomposites thermo-mechanical properties.

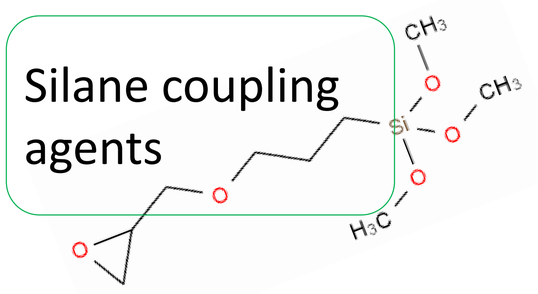
1. Environmental Impact
2. Biocompatibility
3. Mechanical Properties
4. Processability
5. Availability
6. Compostable

Pine fiber

Lignin



Silane coupling agents

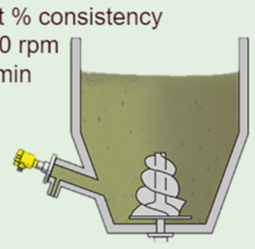


Methodology, results and conclusion

Stage 1

Pine SGW disintegration
pulper

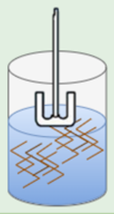
- 5 wt % consistency
- 1100 rpm
- 30 min



Stage 2

Silanization process
GPS coupling agent

- 3 wt % consistency
- 3, 5, 7, and 10% of GPS
- 700 rpm
- 30 min



Stage 3

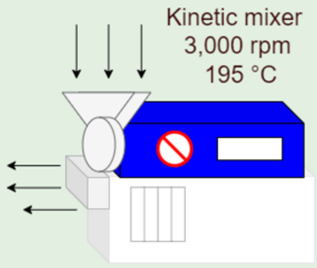
Fiber drying process

- 24 h air dry
- 48 h oven dry at 80 °C

Stage 4

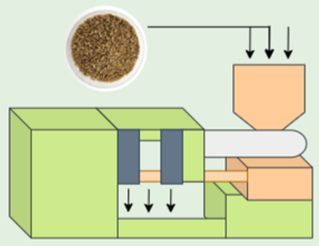
Melting-mixing process
Composite production

Kinetic mixer
3,000 rpm
195 °C



Stage 5

Injection molding
190, 200, 210, 215, 220 °C



Stage 6

Composites characterization

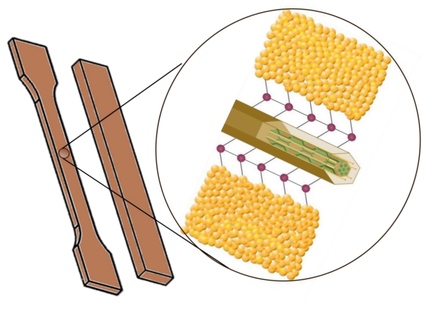
High-performance | Natural fibers (mechanical properties) | Lignocellulosic fiber's amorphous regions Availability of hydroxyl groups

1. Absorbing moisture;
2. Creating a not suitable interfacial adhesion between fiber and polymer;
3. Decrease in the mechanical properties;
4. Loss of dimensional stability;
5. Fiber biodegradation.

Fiber surface treatment

Preserving lignocellulosic fraction

Hydroxyl-rich surfaces as a favorable strategy → Chemical coupling mechanism: Silane bi-functional molecules



PLA SGW for high-performance applications

1. PLA silane-modified and unmodified SGW showed a significant increase in tensile and flexural mechanical properties;
2. Processing properties, density, melt flow index, and melt rheology supported the production of well-bonded biocomposites;
3. Biocomposites are a good alternative to PP reinforced with glass fiber.

Acknowledgments

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