# Xylo-sourced 4D-functionnal packaging for cosmetic

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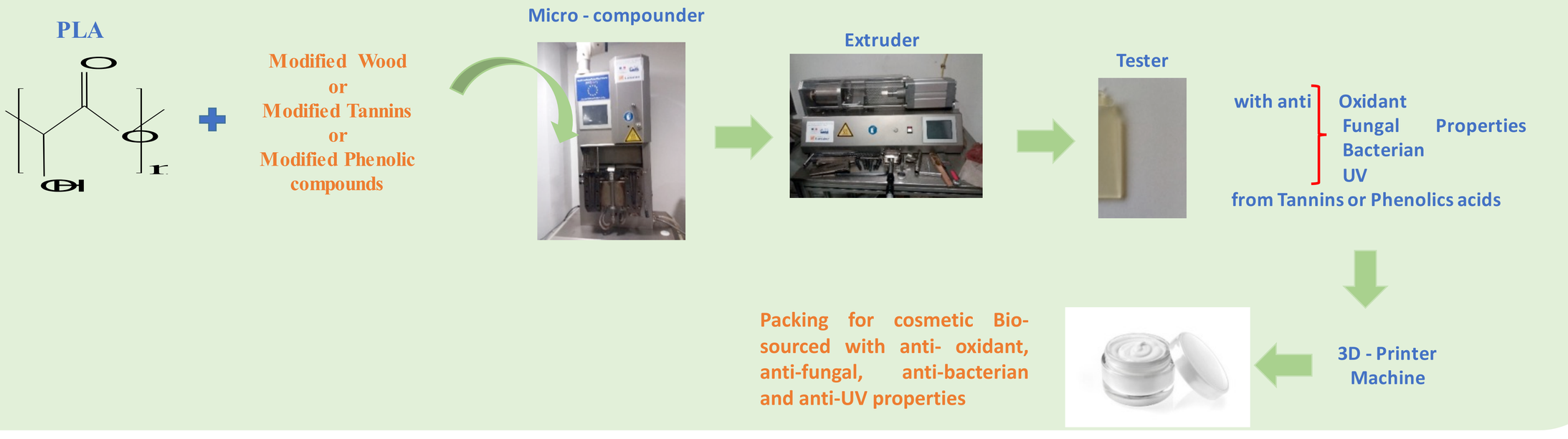
## Introduction

The rationalization of easily accessible fossil resources in the recent years has aroused a growing interest in the use of renewable raw materials. In addition, the industries and consumers are showing more interest to use molecules of natural origin to replace synthesis products of petrochemical origin. In this context, the Forestry Biomass appear as a good alternative to replace the products of petroleum origin for its wide availability and natural origin that give them a green connotation. The latter permit to decrease the number of ingredients in formulations and the obtention of a green product.

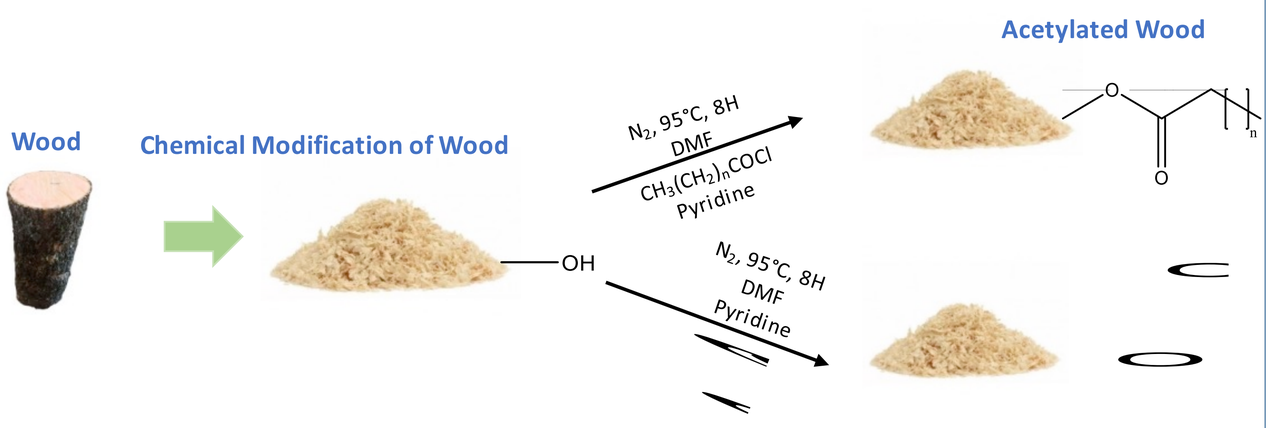
Nowadays, the cosmetic industry has a higher demand of active products in their formulations or in the pack. In this context, the objective of this project is the conception of a bio-sourced pack, synthesized by thermoplastic filaments of chemically modifies wood based or by-products of the industry of first transformation of wood like tannins or phenolics extracts to obtain a 3D printed pack with antioxidants and/or antifungals and /or antibacterial and/or anti-UV properties.

**Main Objective:** 1) Increase the wood biomass in the polymer formulations for print 3D technology to obtain a Bio-sourced material with more stability to heat and hydrolysis of poly(lactic) acid.

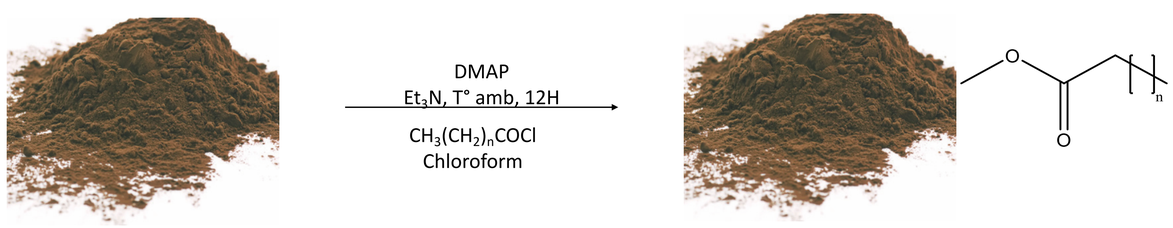
2) Functionalization of the material to provide additional properties that we called the 4th dimension: antioxidants, antifungals, antibacterial and anti-UV properties.


## Wood Modification:




## Tannnins Modification:

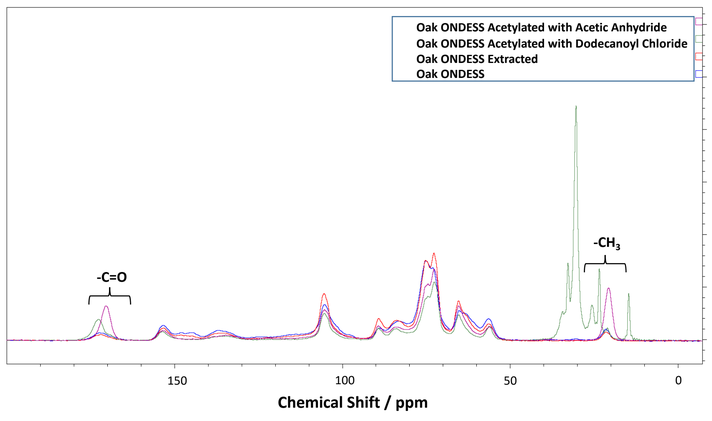



## Characterization of Modified and Unmodified Wood

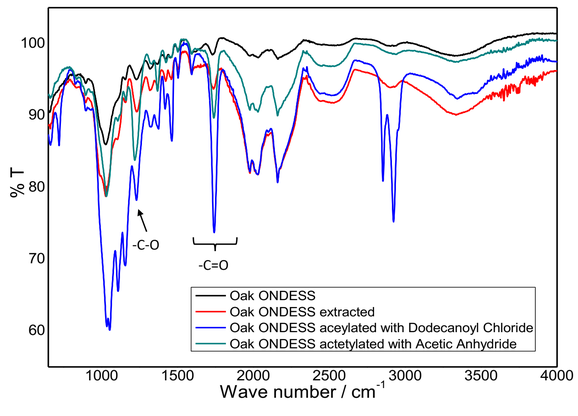
Left: the signal at ~ 22 ppm correspond to a $-CH_3$ carbon of acetyl group, and the signal at ~ 176 ppm correspond to a carbon of carbonyl of acetylated wood –C=O.

Right: the stretching band at ~ 1740 $cm^{-1}$ correspond to a –C=O and the streching band at ~ 1210 $cm^{-1}$ correspond to a –C-O of acetylated wood.

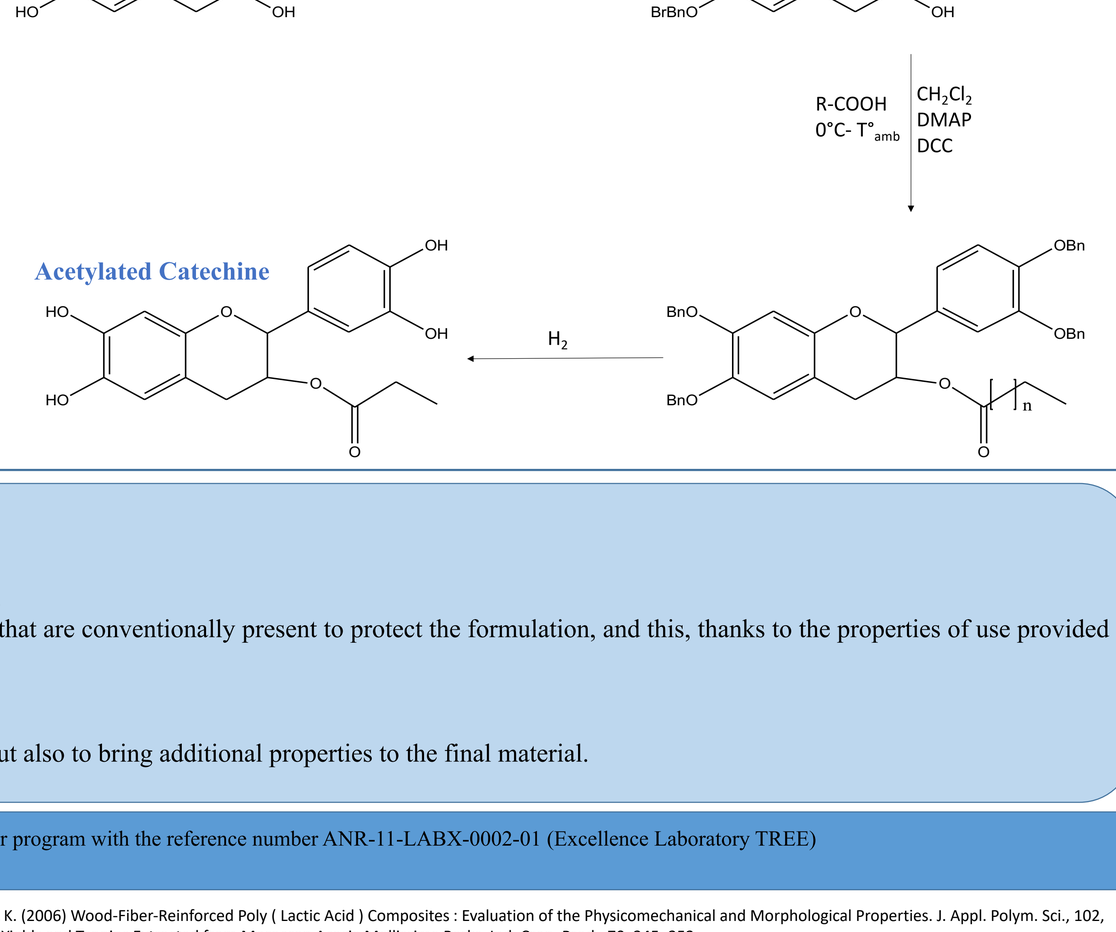
**$^{13}$C Solid NMR**




**IR-TF**




## Phenolic Compound Modification:




## Conclusions

In this way, it is possible to obtain a packaging made from bio-sourced materials, allowing:

- By one hand, conditione the cosmetic formulations in a 100% bio-sourced packaging and with a rendering highlighting the product.
- On the other hand to simplify the cosmetic formulations by reducing the number of preservatives, antioxidants, type of ingredients that are conventionally present to protect the formulation, and this, thanks to the properties of use provided by the container.
- In addition, it provides important added value to forest biomass through the valorization of by-products of the wood industry.

**Perspectives**

We plan to extend the process to the incorporation of modified wood extractants with grafts to improve the compatibility with PLA but also to bring additional properties to the final material.

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**References:** **(1)** Henke, K.; Treml, S. (2013) Wood Based Bulk Material in 3D Printing Processes for Applications in Construction, 2, 139–141. **(2)** Huda, M. S.; Drzal, L. T.; Misra, M.; Mohanty, A. K. (2006) Wood-Fiber-Reinforced Poly ( Lactic Acid ) Composites : Evaluation of the Physicomechanical and Morphological Properties. J. Appl. Polym. Sci., 102, 4856–4869. **(3)** Naima, R.; Oumam, M.; Hannache, H.; Sesbou, A.; Charrier, B.; Pizzi, A.; El, F. C. (2015) Comparison of the Impact of Different Extraction Methods on Polyphenols Yields and Tannins Extracted from Moroccan Acacia Mollissima Barks. Ind. Crop. Prod., 70, 245–252.