Recycling of plastic tube shelters: characterization of the degradation and contamination

I. Bernabé*, S. Rivera*, C. Perou*, F.R. Beltrán*, M.U. de la Orden**, E. Blázquez-Blázquez, M. L. Cerrada***, J. Martínez Urreaga*.***

****Dpto. Ingeniería Química Industrial y del Medio Ambiente, E.T.S.I. Industriales, Universidad Politécnica de Madrid, José Gutiérrez Abascal, 2, 28006-Madrid, Spain.***

*****Dpto. de Química Orgánica I, Facultad de Óptica y Optometría, Universidad Complutense de Madrid.***

******Instituto de Ciencia y Tecnología de Polímeros (ICTP-CSIC), Juan de la Cierva 3, 28006-Madrid, Spain.***

(E-mail: i.bernabe@upm.es)

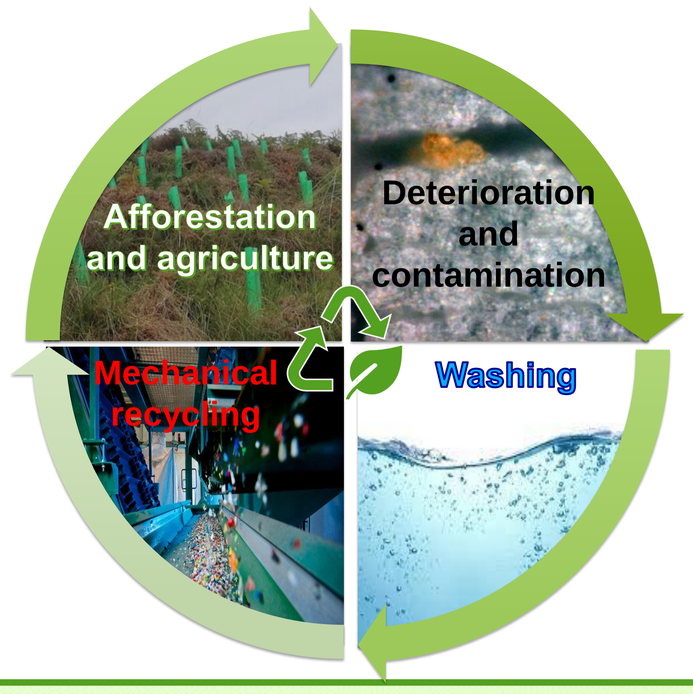
Introduction

Why tube-shelters?

Tube shelters are widely used in afforestation and in agriculture for seedling protection. These tubes are made of different materials; plastics (polypropylene (PP) and polyethylene (PE)) are the most used option. Several thousand tons each year are produced only in Spain. Most of them are not collected and end their lives polluting the environment, resulting in:

Environmental issues: release of microplastics and toxic additives.

Economic issues: material loss



What is the solution?

Recollecting, recycling, and manufacturing to revalorize plastic tube-shelters. In most cases, mechanical recycling is the best end-of-life scenario for a circular economy model. However, mechanical recycling has two problems related to tube shelters:

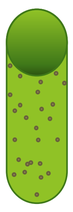
- ❖ High degradation degree of the tubes.
- ❖ High degree of contamination.

What is the objective?

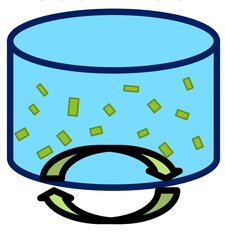
Know the degradation and contamination degree of real tube shelters to assess the interest in its collection and recycling.

Methodology

Tube-shelters
0, 4, 10 and 17 years



Cut + wash

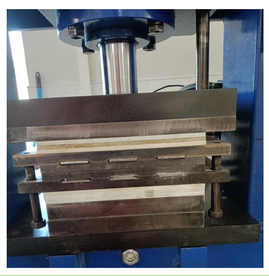


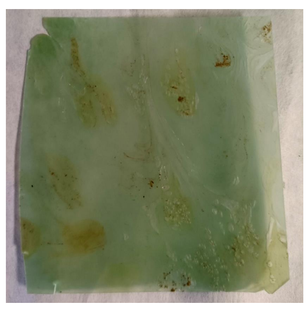
Stirring 25ºC Triton 1%

Drying

105ºC

Press-moulding





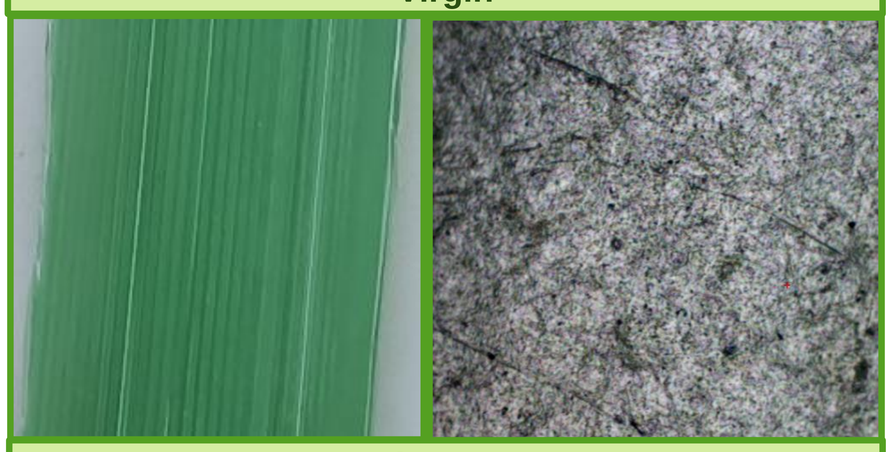
CHARACTERIZATION

- ❖FT-IR
- ❖Raman
- ❖TG
- ❖DSC
- ❖UV-visible

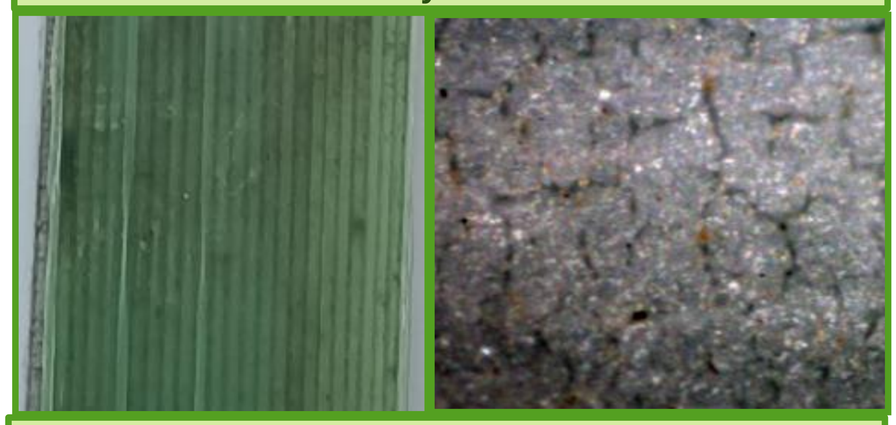
Results & Discussion

Tube-shelters from vineyards

Virgin



4 years



17 years

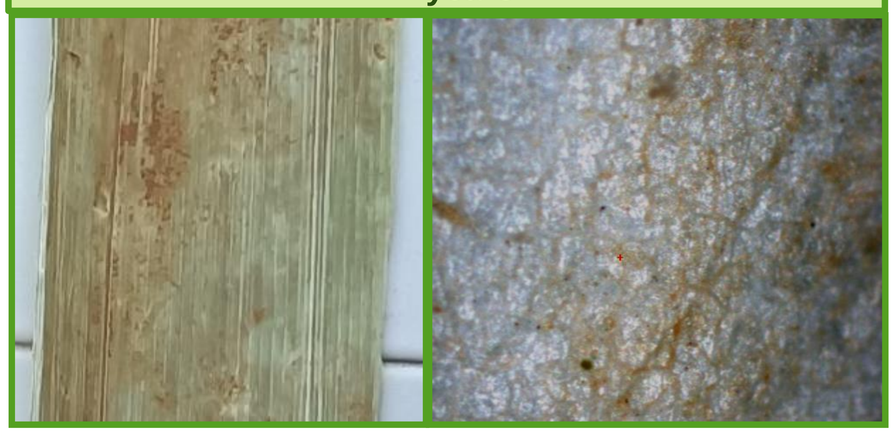


Figure 1: *Appearance and micrographs of tube-shelters: 0, 4 and 17 years.*

Thermal analysis

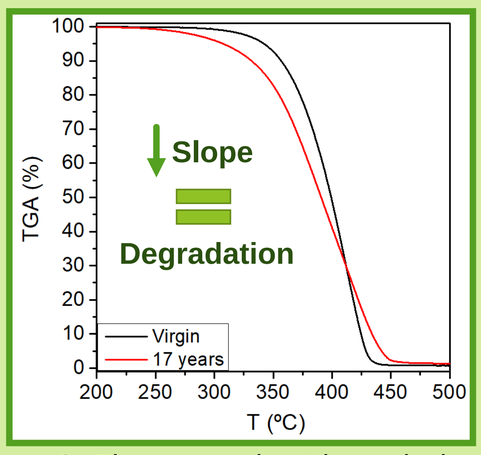


Figure 2: *Thermogravimetric analysis of tube-shelters*

Similar thermal stability → **Tubes can be reprocessed even after 17 years**

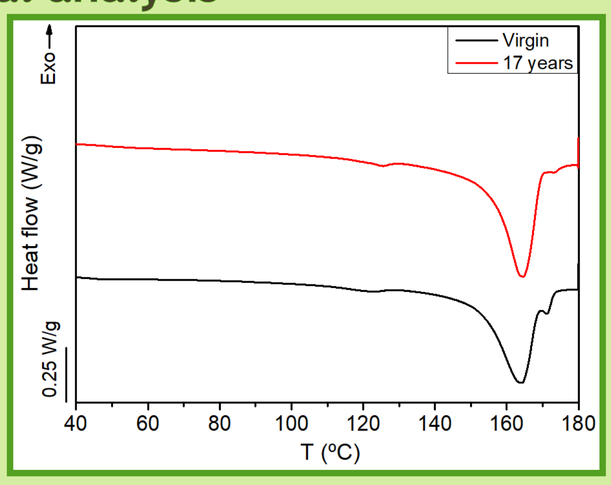


Figure 3: *DSC of tube-shelters*

No notorious changes → **Good candidates for mechanical recycling**

Spectroscopic analysis

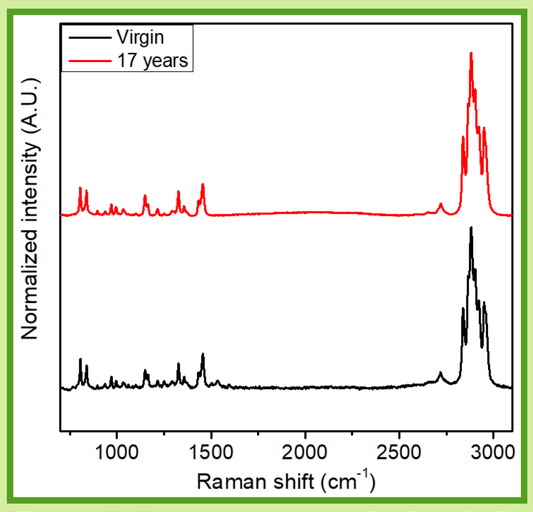


Figure 4: *Raman spectra of tube-shelters.*

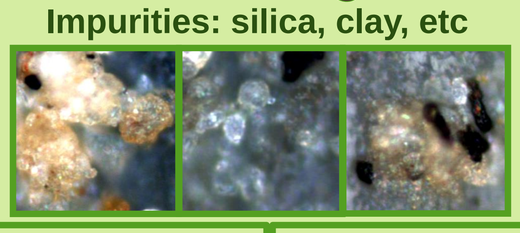
Material:
Commercial PP+PE copolymer

Very slight changes in the chemical composition even after 17 years of use.

Removal of dirt onto the tubes

Washing

Impurities: silica, clay, etc



Before	After

Figure 5: *Micrographs of tubes before and after washing.*

Effective removal of impurities after washing.

Conclusions

- ❖ Tube shelters acquire a big deal of inorganic impurities during its use time. Simple washing procedures are an effective alternative to remove impurities.
- ❖ Although there is polymer degradation, and the tubes become brittle, materials can be reprocessed even after 17 years
- ❖ Mechanical recycling is a proper option to valorise used tube shelters.

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ICTP Instituto de Ciencia y Tecnología de Polímeros

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