Study of mechanical, thermal properties, and biodegradability in polymeric matrix of PHBV materials incorporated with natural fibres

Background

The use of the plastic is increasing in the last decades because presents as a low-cost material, as has several applications. The huge use of plastic is causing environmental pollution, which leads the increasing of studies regarding to replace the plastics for bioplastics and consequently decrease the environmental impact. One of those bioplastics are the PHBV, (poly3hydroxybutyrate-co-3-hydroxyvalerate). Some bioplastics are mixed with natural fibers to test properties for different uses.

Objective

This research intended to produce a new material, mixing PHBV with natural fibres in different proportions and perform experimental evaluations around this compound. The main properties evaluated were thermal properties, mechanical properties and biodegradability. The fibres incorporated were wood and hemp fibres.

Method

Figure 1- Samples of PHBV with hemp fibre moulded by compression moulding buried in soil for starting the biodegradation process.

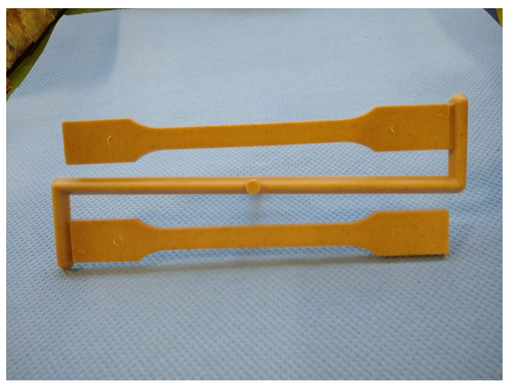

Figure 2- Samples of PHBV with wood fibre moulded by injection moulding for mechanical properties tests.

- The material was extruded in different compositions, either with wood and hemp fibres. The machine used was a twin-screw extruder.
- The samples were moulded by injection moulding and compression moulding,
- The thermal study was performed using a : Differential Scanning Calorimetry
- The mechanical properties of each composition was evaluated according to the ISO 178 – Bending Properties, ISO 179 - Charpy Impact Properties, ISO 527 – Tensile Tests.
- The biodegradation rate was determined per week, with the samples buried in soil in environmental temperature, with the moisture in 80%.

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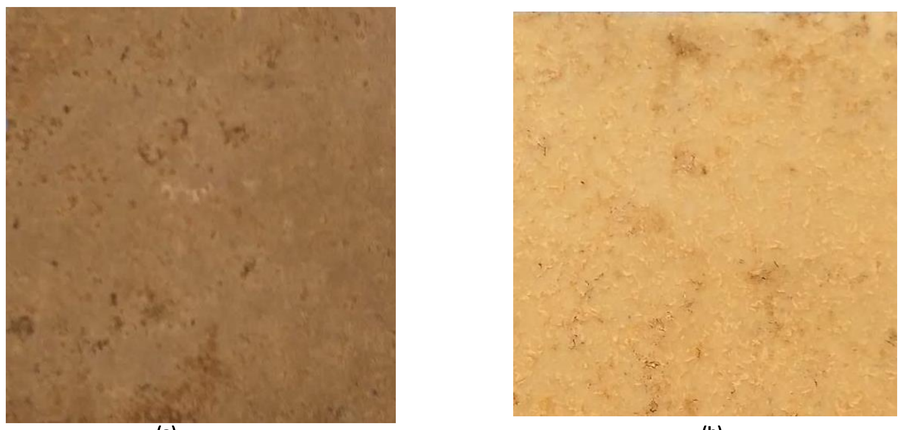
Results

The hemp and wood fibres presented as a physical obstacle for the homogeneity and crystal formation, affecting the rate of crystallization, observed by decreasing the $T_{m.}$

The increase of the fibre content leads to a stiffer and less elastic material. It was seen that compounds with 30% wood fibre can achieve values of Strength at Break property similar to Neat PHBV and a possible use of this material with higher content of wood fibre could lead to a reduction in the material cost without a cutback in this property.

Because of the thermal and mechanical behaviour it is possible conclude that the phases are not well compatible. This disfavours the tensile transfer in the material, and the fibre become a stress concentration point, which can lead to a stiff material with early fracture. In general, the fibres improve the biodegradation rate, but specially hemp showed a higher degree of degradation comparing with the neat PHBV.



(a) (b)

Figure 3- Surface of samples of PHBV with hemp fibre (a) and wood (b) moulded by compression moulding buried in soil for 8 weeks

Conclusions and acknowledgements

The DSC curves showed that the fibres decrease the crystallization degree comparing with the Neat PHBV. The mechanical results showed that with the increase of the fibre content is possible to obtain a stiffer and less elastic material. The results also indicate a low compatibility between fibres and PHBV surfaces. The biodegradability was improved with hemp comparing with Neat PHBV and with wood compounds. To improve the compatibility between surface fibre and polymer, is suggested the use of additives, as plasticizers, in next researches.

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