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BIOTRANSFORMATION OF POLY (ε-CAPROLACTONE) AND POLY (VINYL CHLORIDE) BLEND

Adriana de Campos[1]; Sandra Mara Martins Franchetti[1]*; José Augusto Marcondes Agnelli[2]

[1]Departamento de Bioquímica e Microbiologia, Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, SP, Brasil.
[2]Departamento de Engenharia de Materiais, Universidade Federal de São Carlos, São Carlos, SP, Brasil.

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ABSTRACT

Poly(caprolactone) is a famous biodegradable polymer and miscible with PVC, a commercial synthetic polymer, thermal susceptible and non-biodegradable. This blend is important concerning its mechanical properties and biodegradability. In this work, we testified the biomodification of blend films of PVC/PCL by UV-Vis. spectroscopy. The results show us that there is an interaction between the PVC/PCL film and the microrganisms.

Key words: biotreatment, UV-Vis, PVC/PCL blend, biotransformation.

INTRODUCTION

Plastic contribution to packaging materials is increasing rapidly over the last 20 years. The annual disposal of tons of plastics has raised the demand for means of managing this non-degradable waste stream. Selective use of biodegradable polymers in certain applications might help to reduce the environmental impact of plastic materials (10). Because of their persistence in the environment, polymers became a waste deposit problem (1). As told before, biodegradable polymers consist in a potential solution for this problems and due to this fact, were developed during the last decade (1).

Polycaprolactone (PCL), an aliphatic polyester has a relatively low melting point of 60ºC (3). Biocompatible, biodegradable and non-toxic synthetic aliphatic polyesters in biomedical applications are completely biodegradable inside the body after its interaction with body fluid, enzyme and cells (5). An interesting property of PCL (a good example of an aliphatic polyester) is its propensity to form compatible blends with a wide range of other polymers (3).

The PVC (poly vinyl chloride) is one of the most important commodity plastics in use today (9). It is used in a growing number of applications, like food packaging, toys, pipes, window frame, etc (2).

The deterioration of polymer surface is an interfacial process. If microorganisms are involved in this process, they attach themselves to, and colonize, the surfaces in form of biofilms (4).

Several polymers are currently mixed with PVC to alter its properties, such as high impact behavior, heat resistance temperature and processability. For example, the compatibility, morphology and mechanical properties of PVC blended with PCL gives miscible in all proportions and it was reported to be a very effective plasticizer for PVC (7).

In this work, we have blended PCL with PVC to investigate the biotransformation of PVC/PCL miscible blend by spectroscopy of absorption in the UV-Visible.

MATERIALS AND METHODS

Chemicals

Poly ε-caprolactone was kindly supplied by Department of Material Engineering - UFSCar - São Carlos, SP, Brazil.

Poly (vinyl chloride) (Fig. 2) $M\varpi$ = 145,636g/mol (PVC) - Norvic, without additives, was supplied by Petrochemistry

*Corresponding author. Mailing address: Departamento de Bioquímica e Microbiologia, Instituto de Biociências, Universidade Estadual Paulista. Av. 24 A, 1515, CP 199. 15306-900, Rio Claro, SP, Brasil.

company of Camaçari, Bahia, Brazil. 1,2-dichloroethane, p.a. Reagen- used as received.

Sample Preparation

Films and blends of PVC/PCL 1:1 were obtained by casting from solutions of PVC and PCL in dichloroethane on glass plate at room temperature. The films were dried under vacuum, for 48 hours (8).

Culture Media

The liquid culture medium consisted of a solution of Sabouraud - Malt.

Microbial treatment

Duplicate samples of PVC, PCL and PVC/PCL 1:1 were incubated in Sabouraud -Malt solution during 4 months, at 27ºC. The films and blends were then washed several times with distilled water and dried under vacuum during two days.

UV-Vis spectroscopy

UV-Vis spectra were obtained on a UV-Vis spectrometer Shimadzu, UV-2401 model, at a range 200-800nm.

RESULTS AND DISCUSSION

Spectra films biotreated PVC showed increased absorbance intensity in the range of 250-300 nm, suggesting the presence on matrix (Fig. 1).

Biotreated PCL films presented increased absorption intensity in the range of 260-340 nm related to carbonyl groups (Fig. 2).

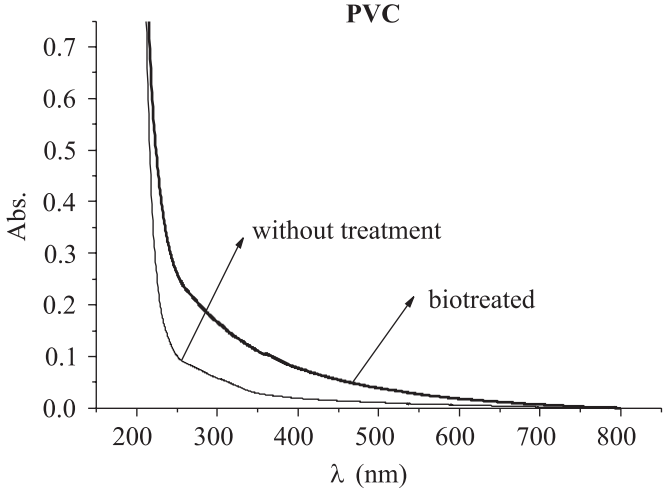

Figure 1. Absorption spetra UV-Vis film PVC without treatment biotreated with *Phanerochaete chrysosporium/Aspergillus fumigatus.*

The spectrum UV-Vis of PVC/PCL biotreated blend showed three sharp bands related to the absorption of carbonyl groups on UV-Vis spectroscopy (Fig. 3).

CONCLUSION

The miscibility and mechanical properties of PVC/PCL blend has been investigated by several techniques (7). The results of UV-Vis showed that the PVC/PCL blend are miscible and the PCL is a very effective plasticizer for PVC.

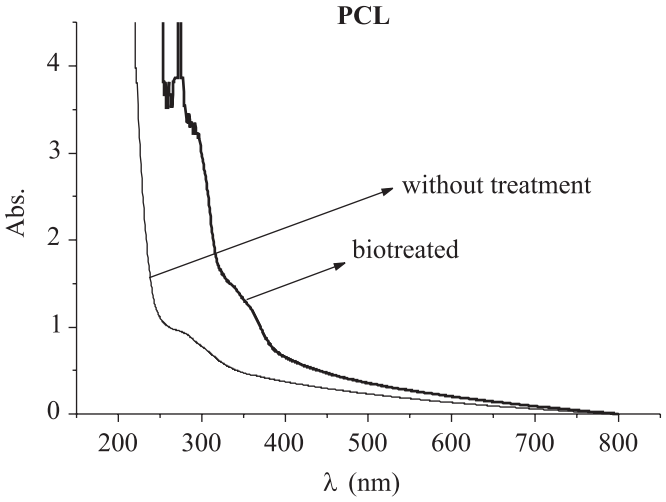

Figure 2. Absorption spetra UV-Vis film PCl without treatment biotreated with *Phanerochaete chrysosporium/Aspergillus fumigatu.*

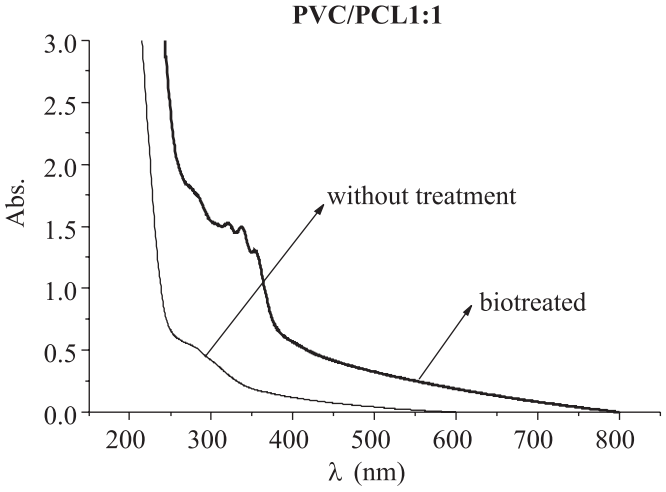

Figure 3. Absorption spetra UV-Vis film PVC/PCl without treatment biotreated with *Phanerochaete chrysosporium/ Aspergillus fumigatus*

The increased presence of carbonyl groups observed in PVC/PCL blends after biotreatment showed structural changes in PVC and PCL polymers, provoked by microorganisms interaction.

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RESUMO

Biotransformação da blenda poli (ε-caprolactona) e poli (cloreto de vinila)

Poli ε-caprolactona é um importante polímero biodegradável e miscível com o PVC, um polímero sintético industrial, termo susceptível e não biodegradável. A blenda PVC/PCL é importante em propriedades mecânicas e biodegradabilidade. Neste trabalho, há indicações que há interação dos microrganismos com a superfície polimérica e esta causa mudanças estruturais na blenda PVC/PCL.

Palavras-chave: biotratamento, UV-Vis, blenda PVC/PCL, biotransformação.

REFERENCES

1. Aboud-Zeid, D.M.; Muller, R.J.; Deckwer, W.D. Degradation of natural and synthetic polyester under anaerobic conditions. *J. Biotechnol*., 86:113-126, 2001.
2. Anon. Curso básico intensivo de plásticos (CBIP). *Jornal de plásticos*, Niterói, 1997
3. Darwis, D.; Mitomo, H.; Yoshii, F. Degradability of radiation crosslinked PCL in the supercooled state under various environments. *Polym. Degrad. Stabil.,* 65:279-285, 1999.
4. Flemming, H.D. Relevance of biofilms for the biodeterioration of surfaces of polymeric materials. *Polym. Degrad. Stabil.*, 59:309-315, 1998
5. Gan, Z.; Fung, J.T.; Jing, X.; Wu, C.; Kuliche, W.K. A novel laser light-scattering study of enzymatic biodegradation of poly (ε-caprolactone) nanoparticles. *Polym.,* 40:1961-1967, 1999
6. Honda, Y.; Osawa, Z. Microbial denitrication of wastewater using biodegradable polycaprolactone. *Polym. Degrad. Stabil.,* 76:321-327, 2002.
7. Karal, O.; Hamarcu, E.; Baysal, B.M. Blends of caprolactone – poly (dy\imetylsiloxane) – polycaprolactone triblock copolymer with poly (vinyl chloride): preparation and characterization. *Polym. Degrad. Stabil.*, 38:6071-6078, 1997.
8. Martins-Franchetti, S.M.; Domingos, R.N.; Tombini, R.C. Modifications on PVC films by ultrasound. *Ultrason. sonochem.*, 9:139-141, 2002.
9. Varma, A.J.; Despande, S.V.; Kondapalli, P. A comparative study of thermal behavior of PVC, a series of synthesized chlorinated polyethylenes and HDPE. *Polym. Degrad. Stabil.,* 63:1-3, 1999.
10. Yavuz, H. Preparation and degradation of L-lactide and ε-caprolactone homo e copolymer films. *Polym. Degrad. Stabil.,* 75:431-437, 2002.