Novel Biodegradable Ester-Based Polymer Blends with Ethylcellulose

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**Summary:** Two PHB/EtC (poly(3-hydroxybutyrate)/ethylcellulose) blends (80/20 and 50/50 w/w) were selected for biodegradation experiments in activated sludge and in enzymatic solution of PHB-depolymerase from *Pseudomonas lemoignei* and from *Aureobacterium saperdae*. Blend morphology was quite different: blend 80/20 was composed of a matrix of impinging PHB spherulites with dispersed EtC inclusions, whereas blend 50/50 was constituted of two continuous phases with interpenetrated domains. Both blends biodegraded in activated sludge but only blend 80/20 was attacked by PHB-depolymerases from *P. lemoignei* and *A. saperdae*.

1. Introduction

Recently poly(3-hydroxybutyrate) and related bacterial poly(hydroxyalkanoates) (PHA) have attracted much attention as biocompatible and biodegradable thermoplastic polymers [1]. Degradation of PHAs occurs both in vivo through hydrolysis of the ester linkage, and in an accelerated fashion in the environment, due to the intervention of extracellular enzymes produced by microorganisms present in soil and water [2-4].

2. Morphology

Microtomed sections of PHB/EtC blends (80/20 and 50/50) were observed between the crossed polars of an optical microscope (Figure 1).



**Figure 1.** Weight-average molecular weight

The micrograph of blend 80/20 (Figure 1) shows a large spherulite which nucleated on the film surface and grew across the whole film thickness (the dark area across the film represents one of the arms of the maltese cross). All over the section of blend 80/20, black spots are observed, that were attributed to phase-separated amorphous EtC. The morphology of this blend was confirmed by optical microscopy (OM) observations of isothermally crystallized samples (Table 1).

**Table 1.** Thermal properties of PHB/EtC

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Head 1 [units]a) | Head 2 | Head 3 | Head 4 | Head 5 [units] |
| Column 1 | Column 2 | Column 3b) | Column 4 | Column 5 |
| Column 1 | Column 2 | Column 3 | Column 4 | Column 5 |

a) Table Footnote; b) Table Footnote.

2.1. Second-Order Heading

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3. Conclusion

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References

[1] ((Journal articles)) a) A. B. Author 1, C. D. Author 2, *Adv. Mater.* **2006**, *18*, 1; b) A. Author 1, B. Author 2, *Adv. Funct. Mater.* **2006**, *16*, 1.

[2] ((Work accepted)) A. B. Author 1, C. D. Author 2, *Macromol. Rapid Commun.*, DOI: 10.1002/marc.#########.

[3] ((Books)) H. R. Allcock, *Introduction to Materials Chemistry*, Wiley, Hoboken, NJ, USA **2008**.

[4] ((Edited books or proceedings volumes)) J. W. Grate, G. C. Frye, in *Sensors Update*, Vol. 2 (Eds: H. Baltes, W. Göpel, J. Hesse), Wiley-VCH, Weinheim, Germany **1996**, Ch. 2.

[5] ((Presentation at a conference, proceeding not published)) Author, presented at Abbrev. Conf. Title, Location of Conference, Date of Conference ((Month, **Year**)).

[6] ((Thesis)) Author, *Degree Thesis*, University (location if not obvious), Month, **Year**.

[7] ((Patents)) a) A. B. Author 1, C. D. Author 2 (Company), *Country Patent Number*, **Year**; b) W. Lehmann, H. Rinke (Bayer AG) *Ger. 838217*, **1952**.

[8] ((Website)) Author, Short description or title, URL, accessed: Month, Year.

[9] …((Please include all authors, and do not use “et al.”))