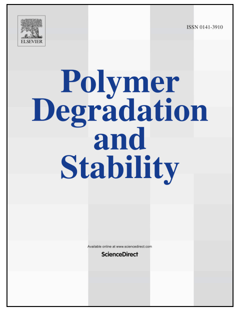
Accepted Manuscript



Metallic phytates as efficient bio-based phosphorous flame retardant additives for poly(lactic acid)

Lucie COSTES, Fouad LAOUTID, Loïc DUMAZERT, José-Marie LOPEZ-CUESTA, Sylvain BROHEZ, Christian DELVOSALLE, Philippe DUBOIS

PII: S0141-3910(15)30002-1

DOI: 10.1016/j.polymdegradstab.2015.05.014

Reference: PDST 7660

To appear in: *Polymer Degradation and Stability*

Received Date: 6 November 2014

Revised Date: 6 May 2015

Accepted Date: 20 May 2015

Please cite this article as: COSTES L, LAOUTID F, DUMAZERT L, LOPEZ-CUESTA J-M, BROHEZ S, DELVOSALLE C, DUBOIS P, Metallic phytates as efficient bio-based phosphorous flame retardant additives for poly(lactic acid), Polymer Degradation and Stability (2015), doi: 10.1016/j.polymdegradstab.2015.05.014.

Metallic phytates as efficient bio-based phosphorous flame retardant additives for poly(lactic acid)

Lucie COSTES(1,2), Fouad LAOUTID(1)*, Loïc DUMAZERT(3), José-Marie LOPEZ-CUESTA(3), Sylvain BROHEZ(2), Christian DELVOSALLE(2) and Philippe DUBOIS(1)*

(1) Laboratory of Polymeric & Composite Materials, Materia Nova Research Center - University of Mons UMONS, Place du Parc 23, B-7000 Mons (Belgium)
(2) Service de Génie des Procédés Chimiques; Faculté Polytechnique - University of Mons UMONS, Place du Parc 23, B-7000 Mons (Belgium)
(3) Centre des Matériaux des Mines d'Alès, Ecole des Mines d'Alès (France)

* Corresponding authors Email address: Fouad.laoutid@materianova.be & Philippe.dubois@umons.ac.be

Abstract

In this study, we evaluated the potential flame retardant effect of different metallic phytates as biosourced phosphorous additives for poly(lactic acid) (PLA). Starting from sodium phytate, the sodium cations were replaced by aluminum, iron or lanthanum cations as attested by elemental analysis. PLA-metallic phytate composites containing 20 or 30 wt% of additives were produced by melt blending in an internal mixer and their fire properties, thermogravimetric resistance have been characterized as well as the PLA chain degradation occurring during melt processing. The most significant flame retardant effect, observed by cone calorimeter test, was obtained when aluminum phytate was used. Cone calorimeter testing combined with pyrolysis combustion flow calorimetry (PCFC) analysis indicated that the barrier effect was more significant in the case of PLA filled with aluminum phytate. However, aluminum phytate proved to be responsible for PLA chain degradation during melt processing. Combination of metallic phytate and native sodium phytate overcome this negative effect and allowed for limiting the thermal degradation of PLA during melt processing with preserving good fire performances, i.e. significant pHRR reduction and V-2 classification in UL-94 test.

Introduction

In the past two decades, a lot of research activities have increasingly focused on the use of renewable resources due to the growing concern on environmental pollution issued from fossil feedstock. Great interest is more and more devoted to improve the sustainability of polymers owing to their importance in our daily life thanks to their high versatility in terms of properties, processing and recycling capability. Poly(lactic acid) (PLA), that represents one of the most promising biosourced polymers, is mainly used in packaging field and biomedical applications [1, 2] taking advantage of relevant mechanical properties such as high stiffness, high degree of transparency, gas permeability and biocompatibility in addition to relatively low cost and large production volume [3, 4]. Recently, some more durable applications for PLA, especially in automotive, electronics, and construction industries have emerged and required PLA grades with improved properties such as higher impact resistance and tensile strength, higher service temperature, i.e., increased head distortion temperature (HDT), long-term stability, increased crystallization extent and kinetics as well as flame retardant behavior.

Flame retardancy is an active research subject developing versatile and efficient strategies to endow polymers with good fire-resistant properties [5]. More and more, the use of new halogen-free flame retardant systems is investigated to reduce health and environmental impact. Flame retardant systems promoting the formation of an insulating char layer during combustion are amongst the most promising strategies to replace halogen flame retardant compounds in PLA. The current trend