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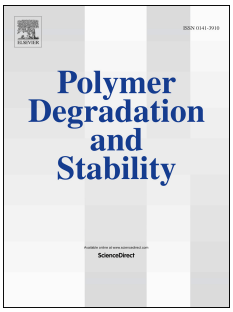

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PII: S0141-3910(16)30144-6

DOI: 10.1016/j.polymdegradstab.2016.05.014

Reference: PDST 7961

To appear in: *Polymer Degradation and Stability*

Received Date: 4 January 2016

Revised Date: 6 May 2016

Accepted Date: 16 May 2016

Please cite this article as: Ding Y, McKinnon MB, Stoliarov SI, Fontaine G, Bourbigot S, Determination of kinetics and thermodynamics of thermal decomposition for polymers containing reactive flame retardants: Application to poly(lactic acid) blended with melamine and ammonium polyphosphate, *Polymer Degradation and Stability* (2016), doi: 10.1016/j.polymdegradstab.2016.05.014.

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Determination of Kinetics and Thermodynamics of Thermal Decomposition for Polymers Containing Reactive Flame Retardants: Application to Poly(lactic acid) Blended with Melamine and Ammonium Polyphosphate

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Abstract

A methodology for parameterization of kinetics and thermodynamics of decomposition of polymeric materials has been extended to blends of a polymer with condensed-phase active flame retardants. This methodology is based on Thermogravimetric Analysis, Differential Scanning Calorimetry, Microscale Combustion Calorimetry and inverse numerical modeling of these experiments. Material systems consisting of poly(lactic acid), melamine and ammonium polyphosphate were used to demonstrate this parameterization process. The resulting model consists of a set of first and second order (two component) reactions that define the rate of gaseous pyrolyzate production, heats of these reactions, heat capacities of the condensed-phase reactants and products and heats of combustion of the components of the gaseous pyrolyzate. This model is shown to reproduce results of all aforementioned experiments with a high degree of detail and predict relation between the outcome of these experiments and material composition. It is expected that a combination of this model with thermal transport parameters, which determination will be a subject of separate study, will yield a complete pyrolysis model capable of predicting the dynamics of burning and flame spread on these materials and dependence of this dynamics on the flame retardant content.

Keywords: material flammability; pyrolysis; intumescence; thermal analysis; inverse modeling; PLA; APP; ThermaKin

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