Accepted Manuscript

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PII: S0141-3910(15)30126-9

DOI: 10.1016/j.polymdegradstab.2015.11.004

Reference: PDST 7782

To appear in: *Polymer Degradation and Stability*

Received Date: 22 July 2015

Revised Date: 15 October 2015

Accepted Date: 2 November 2015

Please cite this article as: Wu G, Li J, Luo Y, Flame Retardancy and Thermal Degradation Mechanism of a Novel Post-chain Extension Flame Retardant Waterborne Polyurethane, *Polymer Degradation and Stability* (2015), doi: 10.1016/j.polymdegradstab.2015.11.004.

Flame Retardancy and Thermal Degradation Mechanism of a Novel Post-chain Extension Flame Retardant Waterborne Polyurethane

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Abstract

A series of novel flame-retardant waterborne polyurethanes (AWPUs) with a phosphorus-containing flame retardant diamine (Bis (4-aminophenoxy) phenyl phosphine oxide (BPPO)) were synthesized by the method of post-chain extension technique and the structure was confirmed by FTIR and NMR. The phosphorus-containing chain extender improved the tensile strength but decreased the elongation at break. Influences of BPPO on the thermal degradation properties and flame retardancy of AWPU's were investigated by thermal gravimetric analysis (TGA), limiting oxygen index (LOI), vertical burning test (UL-94) and cone calorimeter test (CCT). TGA results showed that the post-chain extension of BPPO promoted the degradation process and reduced the thermal stability of AWPUs. LOI, UL-94 and CCT indicated that the flame retardancy was improved with the increase of BPPO. When the chain extension ratio reached 100%, the LOI increased up to 30.1%, PHRR and THR were reduced by 57.1% and 41.6% respectively. The thermal degradation mechanism of AWPUs with chain extension of BPPO was studied by several measurements such as TGA-FTIR, in situ FTIR, SEM and EDS analysis, the results showed that the decomposition of AWPUs were divided into three stages. First of all, BPPO decomposed, and then the degradation of hard segment of AWPUs took place followed by the degradation of soft segment of AWPUs.

Keywords: Waterborne polyurethane; post-chain extension; thermal degradation mechanism; flame retardancy

1. Introduction

Waterborne polyurethanes (WPUs) are non-toxic and tasteless, no pollution to the environment, no danger to the health of operators and cost less [1, 2]. However, there is still a wide gap for the performance of WPUs compared to the solvent-based polyurethane, especially for their poor mechanical properties, which limits their use in the field of anti-corrosion, waterproof, anti-oxidation and so on [3]. Therefore, it needs many efforts to solve these problems, and these studies have become one of the hotspots of concern. In the studies of WPUs, the chain extension

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