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Physicochemical and Thermal Properties of Viscose Rayon Borate Felt

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Abstract: Borate, as a multifunctional material that is a flame retardant, smoke suppressant, afterglow suppressant and electrically resistant, was synthesized on viscose rayon felt using surface modification reactions. In addition viscose rayon phosphate was also synthesized for a comparison test. All reactions were confirmed by ATR FT-IR and TOF-SIMS. The thermal properties of the synthesized viscose rayon borates were investigated using a thermogravimetric analysis and calculated activation energy using the Freeman and Carroll method. The optimal reaction temperature of the synthesized viscose rayon borate was found to be 350 °C. Oxygen index and volumetric resistance rate tests of viscose rayon borate were conducted for flame retardency and electrical resistance, and compared with viscose rayon phosphate. The synthesized viscose rayon borate showed excellent physicochemical and thermal properties, and was found to be a highly effective flame retardant and electrically resistant.

Keywords: *viscose rayon borate, flame retardant, electrical resistance, activation energy, surface modification.*

Introduction

In recent years, the development of halogen-free fire-retardant polymers which do not produce any corrosive and toxic hydrogen-halide gases during combustion has been a subject of considerable interest even though halogen-containing polymers show a high flame-retardency effect [1-4]. As such, phosphate compounds have been highlighted as non-toxic, inexpensive, and good flame-retardant materials [5,6]. However, these compounds have a problem of low insulation due to their high electrical conductivity [7-9]. This means that phosphate compounds can not be used as the covering material for a high-voltage electric wire. Accordingly, this study developed a dual functional material with both high electrical resistance and flame retardency.

Borate is well known as a unique multifunctional fire retardant. It can function as a flame retardant, smoke suppressant, afterglow suppressant, as well as an anti-tracking agent in polymers [10]. Boron compounds act in the condensed phase by redirecting the decomposition process in favor of carbon formation rather than CO or CO_2 formation. A second mechanism involves the formation of a surface layer of protective char, which prevents the oxidation of carbon by limiting the accessible oxygen. In both cases a char is formed [11].

The aim of this work was to prepare halogen-free carbon fibers and study their ability for flame retardency. The activation energy of the thermal degradation of a polymer has been a means for studying the role of flame retardency. Freeman and Carroll [12], Broido [13], and Dave and Chopra [14] suggested kinetic equations for determining the activation energy. Kaur and co-workers [15] all described that the activation energy decreases with an increased percentage of flame- retardency.

This study is to describe the physicochemical and thermal properties of synthesized viscose rayon borate, to establish a reaction mechanism of viscose rayon and boric acid and to test dual functional role of the synthesized viscose rayon borate.

The surface chemical structures of the synthesized viscose rayon borate were analyzed using attenuated total reflectance Fourier transform infrared spectroscopy (ATR FT-IR). Thermal properties were investigated using a thermogravimetric analysis (TGA) and calculated

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