DURABILITY AND ANTIMICROBIAL PROPERTIES FOR FLAME RESISTANT COTTON

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Abstract

In this paper we will discuss the design, synthesis, and characterization of new epoxy phosphonate monomers, (2-methyl-oxiranylmethyl)-phosphonic acid dimethyl ester (**1)** and [2-(dimethoxy-phosphorylmethyl)-oxyranylmethyl]-phosphonic acid dimethyl ester (**2)** (Fig.1) that impart flame resistance to cotton regardless of fabric construction. Our next step was to assay their effectiveness to resist flame propagation on treated fabrics of different constructions (plain weave, twill, fleece and carpet) using the modified pill test (Fig.2) and the vertical flame test ASTM D6413-99 (Fig.3). Complete structural characterization of new compounds will be provided by nuclear magnetic resonance techniques in the solution and solid states involving ^{1}H, ^{13}C, and ^{15}N (Fig.4). Data from thermogravimetric (TGA) and differential scanning calorimetry (DSC) along with flammability test data will illustrate the usefulness of the new treatments in traditional and emerging market applications. In addition, we will discuss the effects of laundering on textile flammability as well as preliminary antimicrobial properties.

Figure 1. Structures, ^{1}H and ^{13}C NMR Data for Monomer **1** & **2**

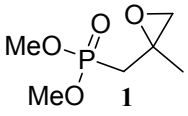
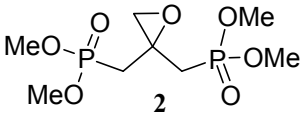
 **1**	 **2**
^{1}H NMR (400MHz, $CDCl_3$): δ-ppm: 1.37, 1.78, 2.15, 2.56, 2.65, 3.62-3.66 ^{13}C NMR (125MHz, $CDCl_3$): δ-ppm: 22.0, 32.6, 33.9, 52.1-52.4, 52.6, 53.7	^{1}H NMR (400MHz, $CDCl_3$): δ-ppm: 2.17, 2.39, 2.79, 3.63-3.70 ^{13}C NMR (125MHz, $CDCl_3$): δ-ppm: 30.8, 31.9, 51.4, 52.2-52.5, 53.4.

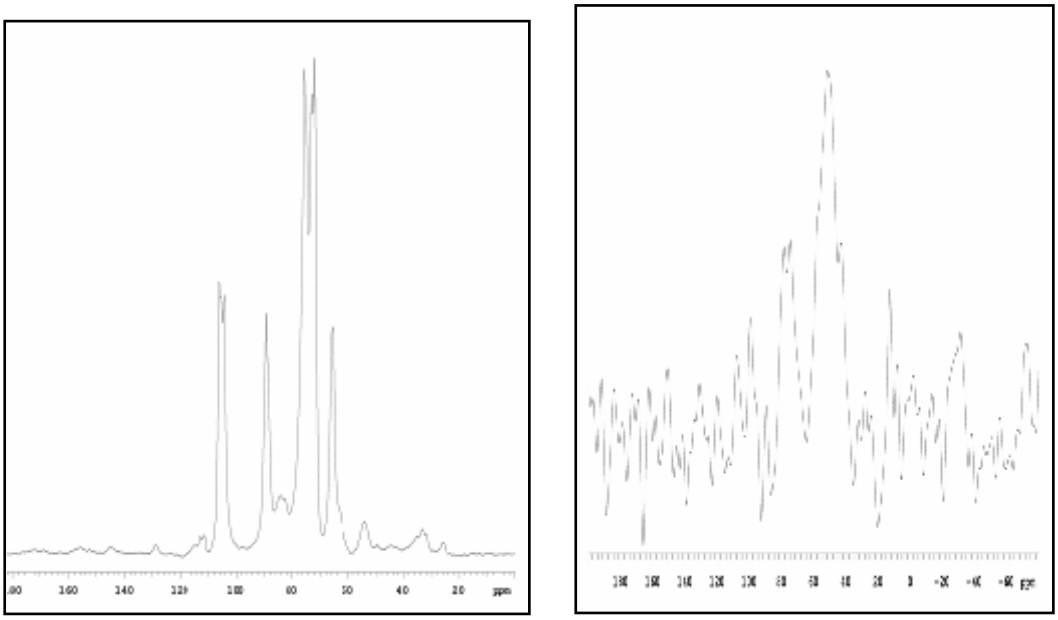
Figure 2. Preliminary Modified Pill Test (Ref.1)

	Plain weave	Twill	Fleece	Carpet
Textiles treated with **1**				
Textiles treated with **2**				

Figure 3. Vertical Flame Test by ASTM D-6413-99

Print cloth (ρ=106g/m2)	Twill fabric (ρ=290g/m2	Fleece fabric (ρ=241g/m2)		Print cloth (ρ=106g/m2)	Twill fabric (ρ=290g/m2)	Fleece fabric (ρ=241g/m2)
			← Treated with **1** Treated with **2** →			
21.6	12.7	23.5	Add on (%)	13.8	8.4	18.0
0	0	0	After-flame time (sec)	0	0	0
0	0	1.5[0.29]	After-glow time (sec) [σ]	0	0	1.25[0.25]
10.5[0.20]	12.9[0.13]	11.0[0.20]	Char length (cm) [σ]	10.3[0.14]	13.6[0.24]	12.6[0.24]

Figure 4. CP/MAS ^{13}C (left) and ^{15}N (Right) NMR Spectrum of Print Cloth treated with **2**



Reference

Blanchard, E.J.; Graves, E.E.; Salame, P.A. *J. Fire Sciences*, 2000, *18*, 151-163