Resinate® Materials Group
Lignin Polyols for Improved Flame Retardant Performance
February 12, 2019

Performance-driven green chemistry.™

Resinate Materials Group®

Performance. Value. Sustainability.

Quick Facts

Headquarters:
Plymouth, Michigan
Active Patents:
34 (20 Granted)
Executive Industry Exp:
180+ years
Facility Sq. Ft:
8,200
Awards:
2017 ASC Innovation Award

Green Chemistry:

- 13 BioPreferred® products
- All products have green focus or content.

Description

- Incorporated in 2011 by private investors with a vision to manufacture polyester polyols from recycled PET and further develop them into polyurethane dispersions (“PUD”) for coatings and adhesives
- In 2014, Resinate shifted its focus from PUDs to polyols in order to expedite its path to revenue and reach a larger market. Routes to revenue;
  - Sale of Resinate Brand polyols
  - Licensing Agreements
  - Contract Research

Starkweather Laboratories

- Resinate’s core technology is now focused on specialty polyester polyols. Resinate formulates with recycled content whenever possible, supplemented by renewable materials for up to 100% green content
- Resinate’s technology focus includes specialty polyols for Coatings, Adhesives, Rigid Foam, and Flexible Foam applications
- Resinate is able to differentiate itself not only through an extensive portfolio of active patents, but also through a lean organization and customer responsiveness. Expert and experienced resources are focused on developing innovative technology and responding to customer needs within days

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Recycled PET
and Polycarbonate, PBT

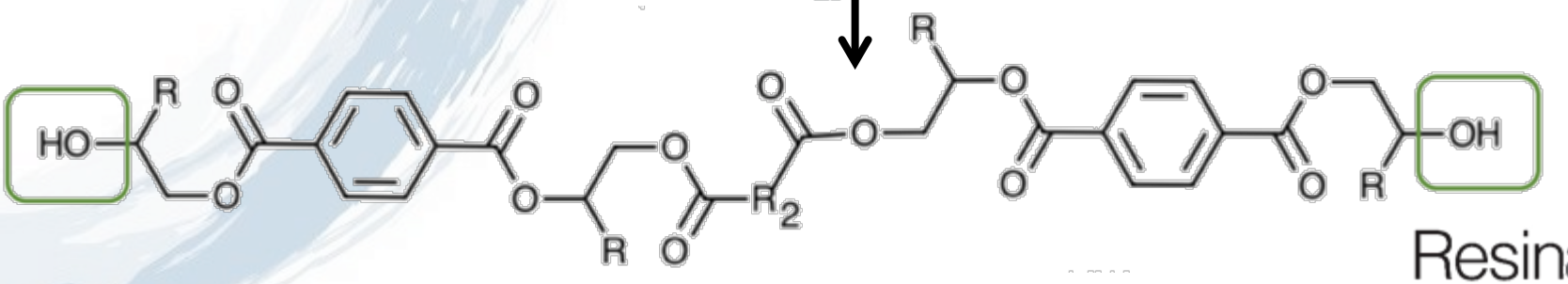
Recycled
Glycols

Biorenewable
Ingredients

Performance

Resinate High Performance
Polyols for Specialty Applications

Glycolysis Process



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Rigid Foam Flame Retardants

- In the late 1990's pentane (essentially gasoline) largely replaced CFCs as the predominant, most cost effective PIR blowing agent, causing an increase in the use of halogenated FR agents

- Today, certain halogenated FR agents are being banned due to concerns related to:
  - Bioaccumulation in humans;
  - Toxicity;
  - Carcinogenicity; and
  - Harm to the environment

- In response, Resinate Materials Group has developed **non-halogenated, reactive FR enhancement *additives*** that provide improved FR performance in aromatic polyester polyol systems
- Resinate Materials Group has also developed **lignin polyols** with improved FR performance and bio-renewable content.

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PIR Foam Formulation

B-Side Material	PPH
Polyol	100
TCPP	18
Potassium Octoate Catalyst	2.3
Tertiary Amine Catalyst	0.2
Silicone Surfactant	3.8
Water	0.5
n-Pentane	25.5

A-Side Material	NCO Index
pMDI*	260

*Polymeric methylene diphenyl diisocyanate with a functionality of 2.7 and equivalent weight of 135

Procedure

- B-side blended with Cowles blade for 1-2 min at 2,000 rpm (until stable)
- A-side added, blended at 2,000 rpm for 15 sec, poured into box
- Recorded cream, gel, rise, and tack free time

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Resinate Non-Halogenated FR Additive Polyol Performance

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Resinate Non-Halogenated Reactive FR Additive FA1401-66*

PIR Foams

- 260 PMDI Index;
- 1.8 pcf density;
- n-Pentane blowing agent;
- **17 pph TCPP**

Modified CAL TB-117 Vertical Flame Test

https://www.youtube.com/watch?v=zsXGlvEgz0U

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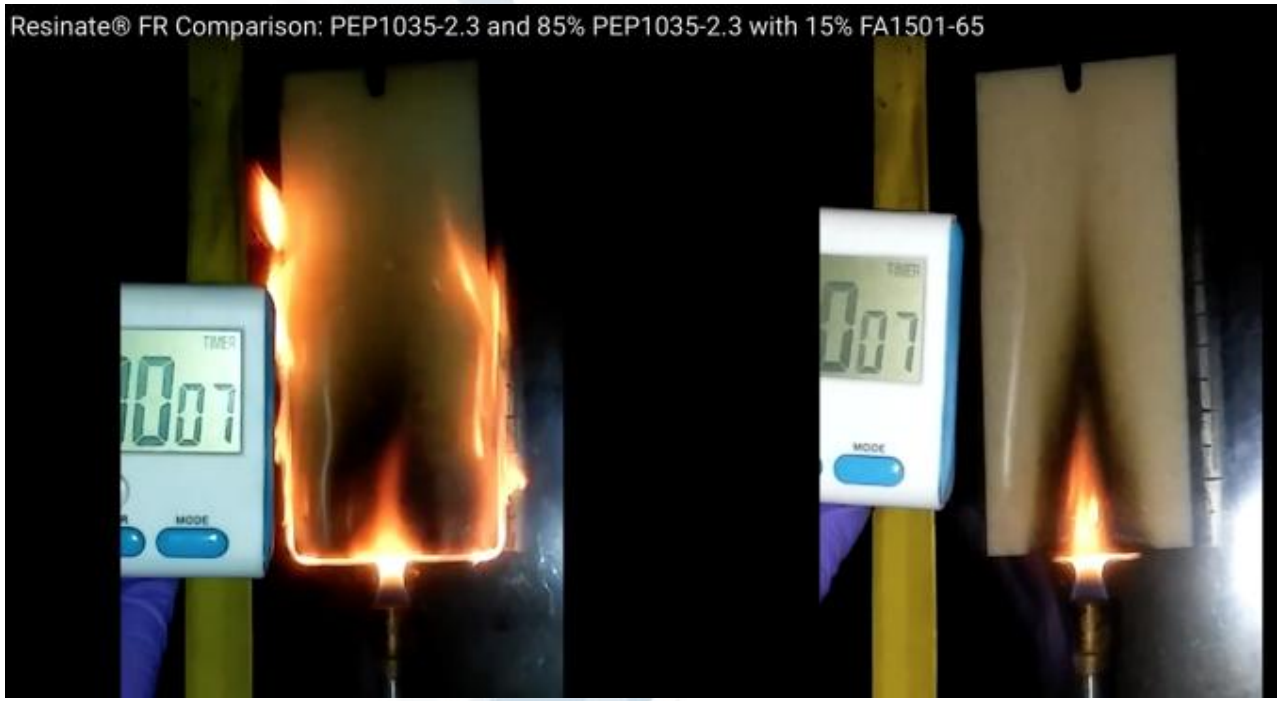
* patents pending

Resinate Non-Halogenated Reactive FR Additive FA1501-65*



PIR Foams

- 260 PMDI Index;
- 1.8 pcf density;
- n-Pentane blowing agent;
- **10pph TCPP**

https://www.youtube.com/watch?v=33YEzC4imlM

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* patents pending

Resinate Lignin Polyols

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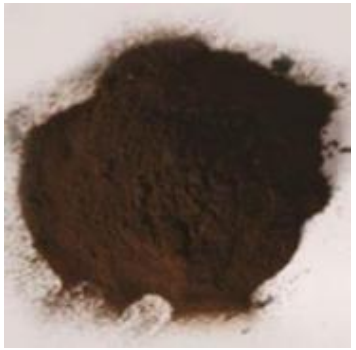
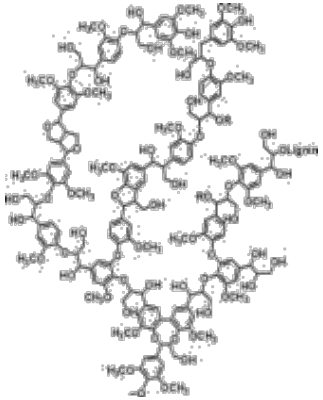
Lignin Polyols

Polyol Designation	LNP1000-5.5*	LNP1000-5.8*
Polyol Type	Recycled PET	Recycled PET
Applications	General Purpose, Spray Foam, Rigid Foam	General Purpose, Spray Foam, Rigid Foam
Lignin Content, wt. %	5%	10%
OHV (mgKOH/g)	279	304
Viscosity at 25C, cps	ca. 3400	ca. 5400
Green Content (wt%)	85.9%	72.3%
Functionality	>2	>2





- Resinate has 3 granted US patents on lignin polyol technology - US 9,481,760; US 9,751,978; US 9,988,489; and 4th pending.
- Fall 2018 – Resinate awarded grant from the Environmental Protection Agency to further enhance the performance and commercialize these polyols.

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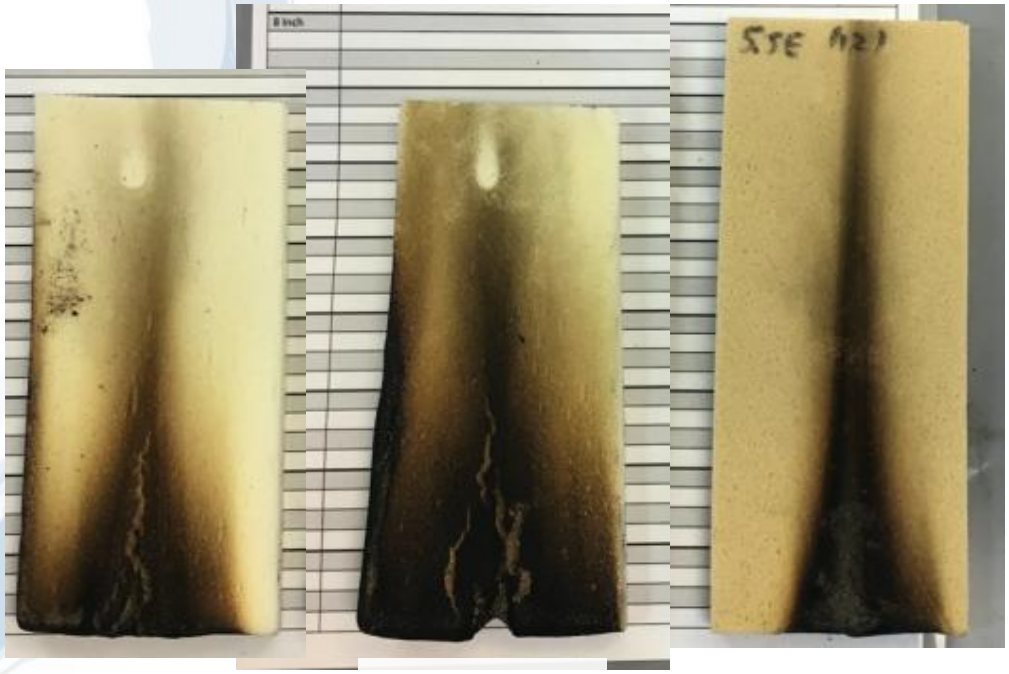
* patent pending

Lignin Polyol* Test Results via CAL TB-117

Polyol Type	PET Polyol	Commercial PA Polyol	Resinate LNP1000-5.5E
%TCPP	12	12	12
%Lignin	0	0	5
OHV	247.0	240.0	291.0
%Mass Loss	4.1%	14.6%	**1.3%**
Flame Spread (in)	>6	>6	**4**
Flame Out (sec)	<1	<1	<1



PET Polyol

Commercial PA Polyol

Resinate LNP1000-5.5E

*(US 9,481,760; US 9,751,978; and US 9,988,489)

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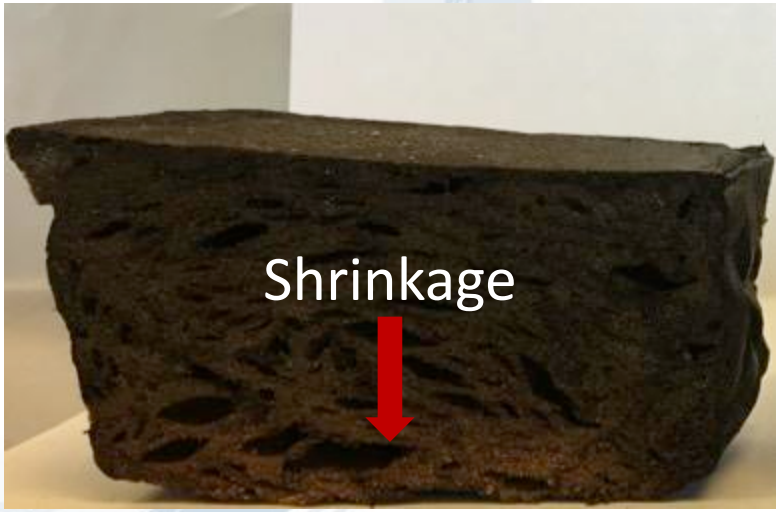
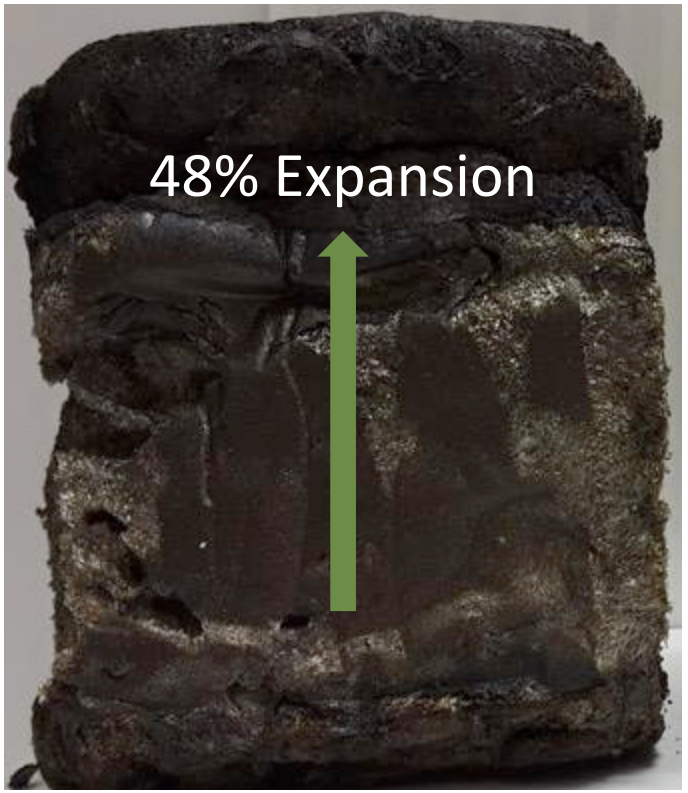
rPET/Lignin Polyols*

Char Testing Results

450°C Oven, 20 min.



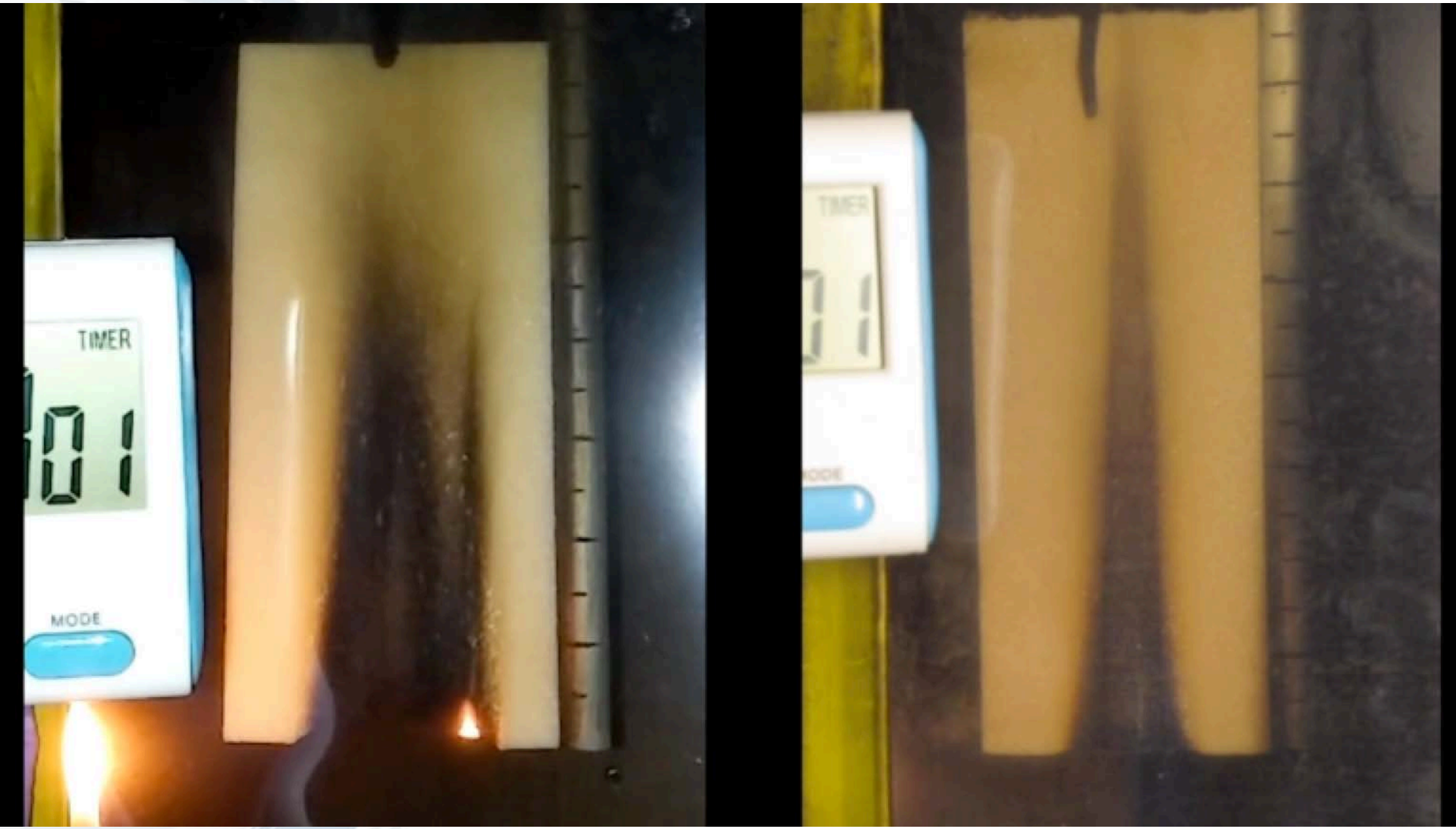
Phthalic Anhydride Polyol



rPET Polyol with 10% Lignin Content
(rPET polyol alone expands about 20%)

* US 9,481,760; US 9,751,978; US 9,988,489

Resinate Lignin Polyol



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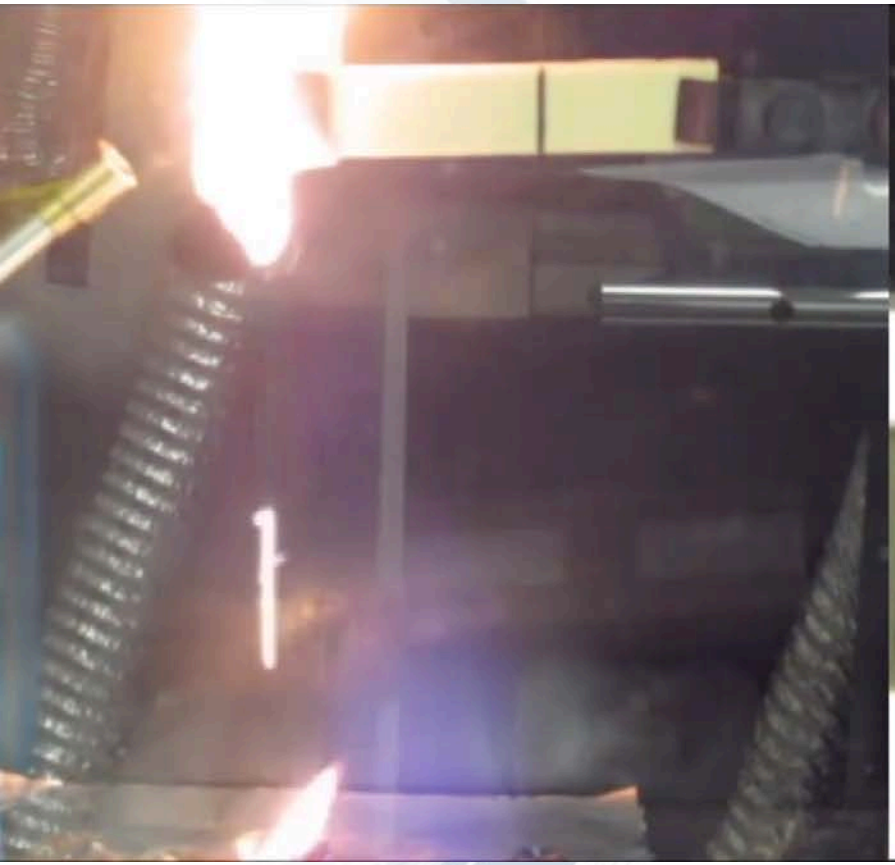
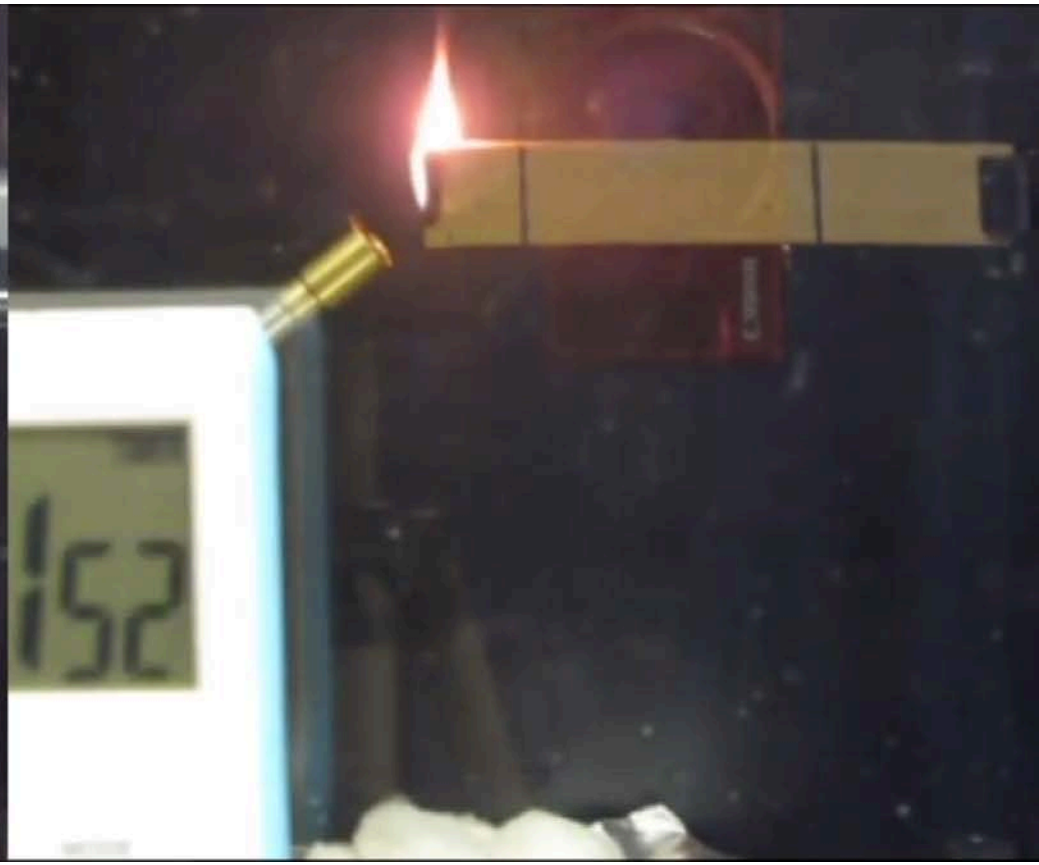
Lignin FR Additive Polyols*

Polyether Polyol Elastomers



10 pph Fyrol 6



10 pph Fyrol 6 + 10% Lignin FR Additive

https://www.youtube.com/watch?v=qE4p4XiAbIM

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Contacts

Rick Tabor
Chief Technology Officer
O: (734) 233-3083
E: rick.tabor@resinateinc.com

Jason Rochette
Research Associate
O: (734) 372-0013
E: jason.rochette@resinateinc.com

Mark Maxwell
Business Director
O: (734) 527-4248
E: mark.maxwell@resinateinc.com

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