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Introduction

The term 'Wildland-Urban Interface' (WUI) refers to the area where homes and secondary structures are built in close proximity of forests, grasslands or wildland vegetation in general. The number of communities located in WUI areas is constantly expanding and is now more than 75,000 in the United States. As a result, the risk posed by wildfires to human lives and properties is increasing, and a large effort to limit the impact of WUI fires on communities is ongoing [1-3]. In WUI fires, building-detached fuels and, in particular, fences can act like "fire lines" that promote rapid flame spread throughout the community [3]. In this work, commercial fire retardant (FR) coatings are applied to wood-based materials to inhibit the combustion of detached fuels and thereby harden the communities. Preliminary results on the commercial coatings have been obtained by Micro-Scale Combustion Calorimetry (MCC) and Cone Calorimetry.

Market Research

7 commercial FR coatings:

- 4 film-forming coatings (3 water-based) (1 organic solvent-based)
- 3 penetrating coatings (stains) (water-based)

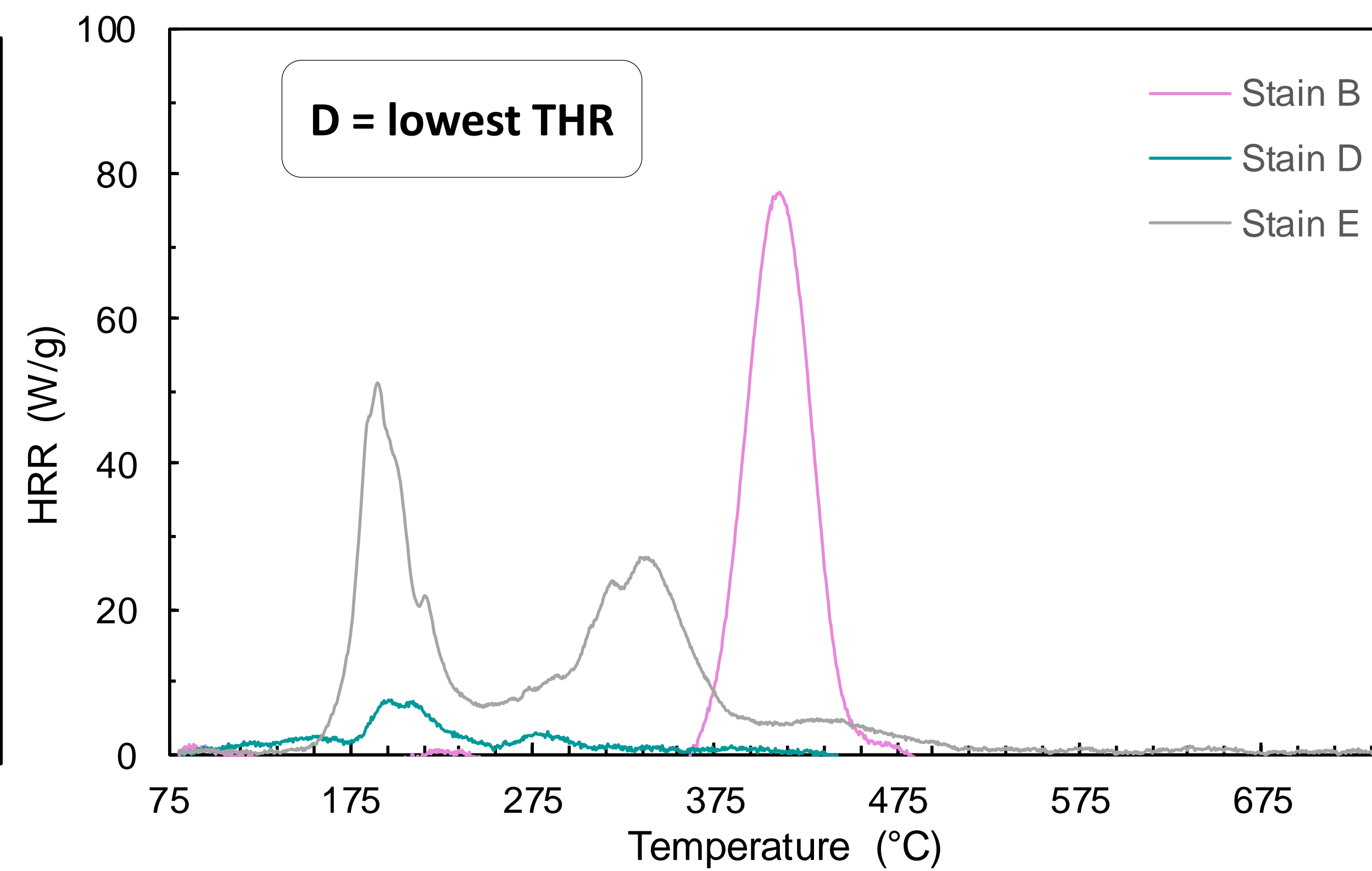
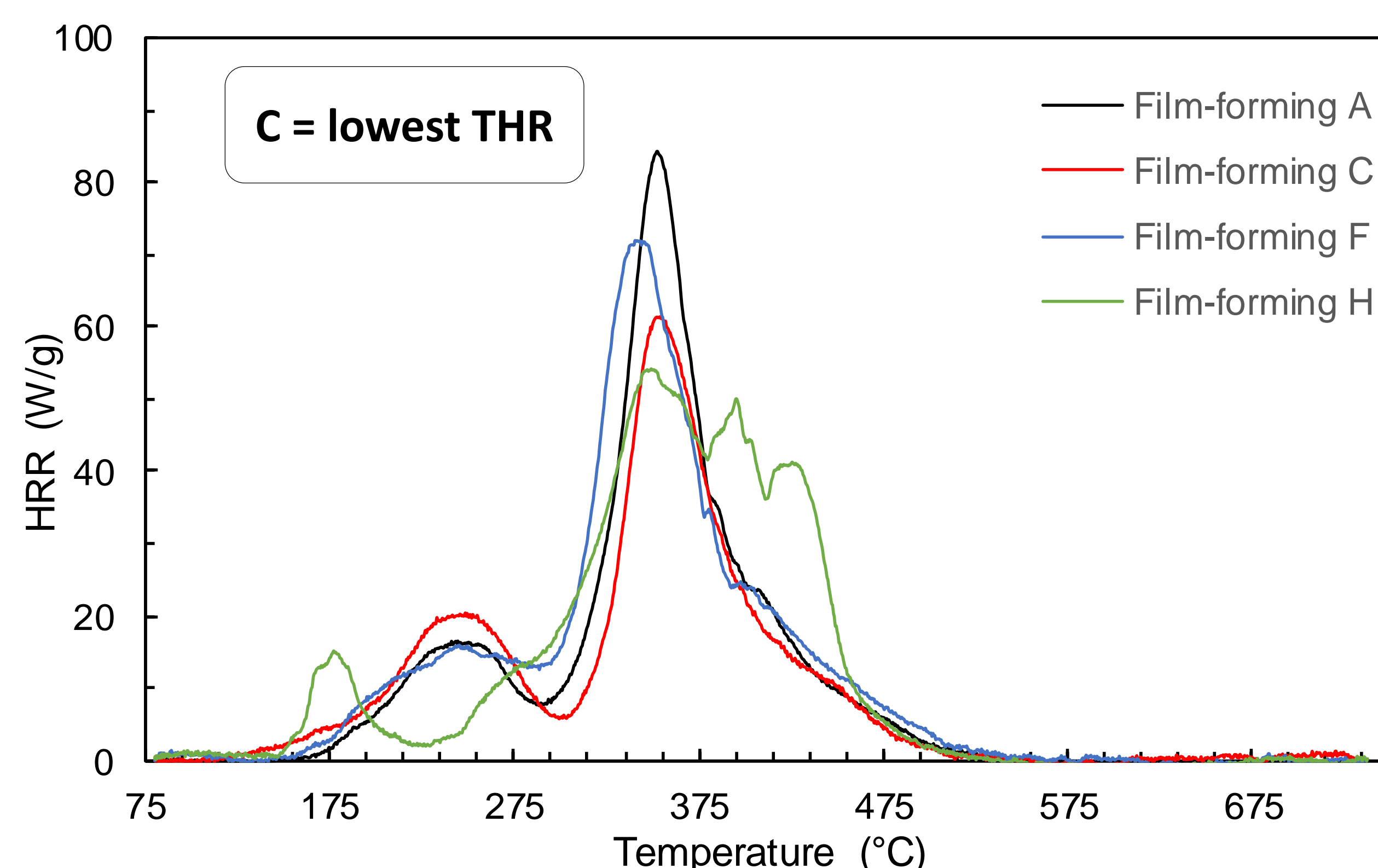
Physicochemical properties of commercial products

According to ASTM D2369, D1475 and D792

Product	Name	Solid Content (mass %)	Density		Matching FR by FTIR spectroscopy
			Initial	Final	
Film-forming	A	62.8 ± 0.1	1.2808 ± 0.0150	1.3184 ± 0.0019	Melamine / Pentaerythritol
	C	61.5 ± 0.4	1.3575 ± 0.0062	1.5017 ± 0.0076	Pentaerythritol
	F	47.3 ± 0.1	1.2381 ± 0.0090	1.4303 ± 0.0137	Melamine / Pentaerythritol
	H	75.1 ± 0.2	1.3755 ± 0.0022	1.6616 ± 0.0180	Melamine
Stain	B	13.9 ± 0.0	1.0650 ± 0.0025	1.2798 ± 0.0012	Pentaerythritol
	D	15.3 ± 0.1	1.0815 ± 0.0036	1.4227 ± 0.0056	Ammonium Phosphate
	E	28.3 ± 0.1	1.1358 ± 0.0024	1.4835 ± 0.0127	Guanidine Phosphate

Experimental

Micro-Scale Combustion Calorimetry



75 °C → 750 °C
1 °C/s
Heat Release Rate (HRR) measurement

Film-forming	THR ^a (kJ/g)	PHR ^b (W/g)	TPHR ^c (°C)	Residue (mass %)
A	6.9 ± 0.2	85.5 ± 1.8	352.5 ± 1.3	45.8 ± 1.0
C	6.2 ± 0.2	62.9 ± 1.4	349.2 ± 1.1	49.8 ± 0.2
F	7.3 ± 0.2	71.3 ± 0.4	341.2 ± 1.8	39.7 ± 1.8
H	7.7 ± 0.3	48.8 ± 0.9	395.0 ± 2.1	37.4 ± 0.4

Stain	THR (kJ/g)	PHR (W/g)	TPHR (°C)	Residue (mass %)
B	3.9 ± 0.3	79.3 ± 3.9	405.3 ± 1.2	68.5 ± 0.6
D	1.5 ± 0.6	N/A	N/A	16.9 ± 0.4
E	4.0 ± 0.3	26.4 ± 0.9	337.5 ± 5.4	35.6 ± 0.5

^aTotal Heat Release, ^bPeak Heat Release, ^cTemperature to Peak Heat Release

Lumber	THR (kJ/g)	PHR (W/g)	TPHR (°C)	Residue (mass %)
Uncoated	11.6 ± 0.1	140.2 ± 6.5	386.8 ± 4.1	14.4 ± 0.6

Cone Calorimetry

Flaming experiment → 50 kW/m²

ASTM E1354, intumescent samples → 60 mm between cone and sample

Sample	Time to ignition (s)	Time to flame-out (s)	THR ^a (MJ/m ²)	PHR ^b (kW/m ²)	Mass loss (g)
Uncoated	18	485	49.8	197.7	32.5
Film-forming					
A	26	28	0.6	43.7	4.7
C	N/A	N/A	0.4	6.4	3.7
F	79	868	47.4	120.1	35.2
H	18	31	1.8	128.4	2.5
Stain					
B	30	650	60.6	202.4	41.6
D	18	583	51.5	159.5	33.4

^aTotal Heat Release, ^bPeak Heat Release

Preliminary results only, replicate tests will be conducted



Uncoated lumber

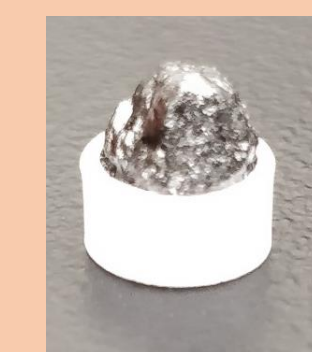


Film-forming C

Film-forming C
→ No ignition + char formation
lowest THR/PHRR and mass loss

Stains have lower THR than film-forming coatings

Except for stain D, all show intumescent properties



References:

- [1] Radeloff, V.C, Ecological Application, 2005.
- [2] Stein, S.M. Gen. Tech. Rep, DOA, 2013.
- [3] Maranghides, A., NIST report 1909, 2011.

Status – completed:

- Coating of wood samples
- Characterization of coating physicochemical properties
- Micro-scale combustion calorimetry of coatings

Future work:

- FR pressure treated lumber
- Cone Calorimeter experiments + smoldering tests
- Accelerating weathering of coatings