

# Assessing Material Consistency Using Microscale Combustion Calorimetry

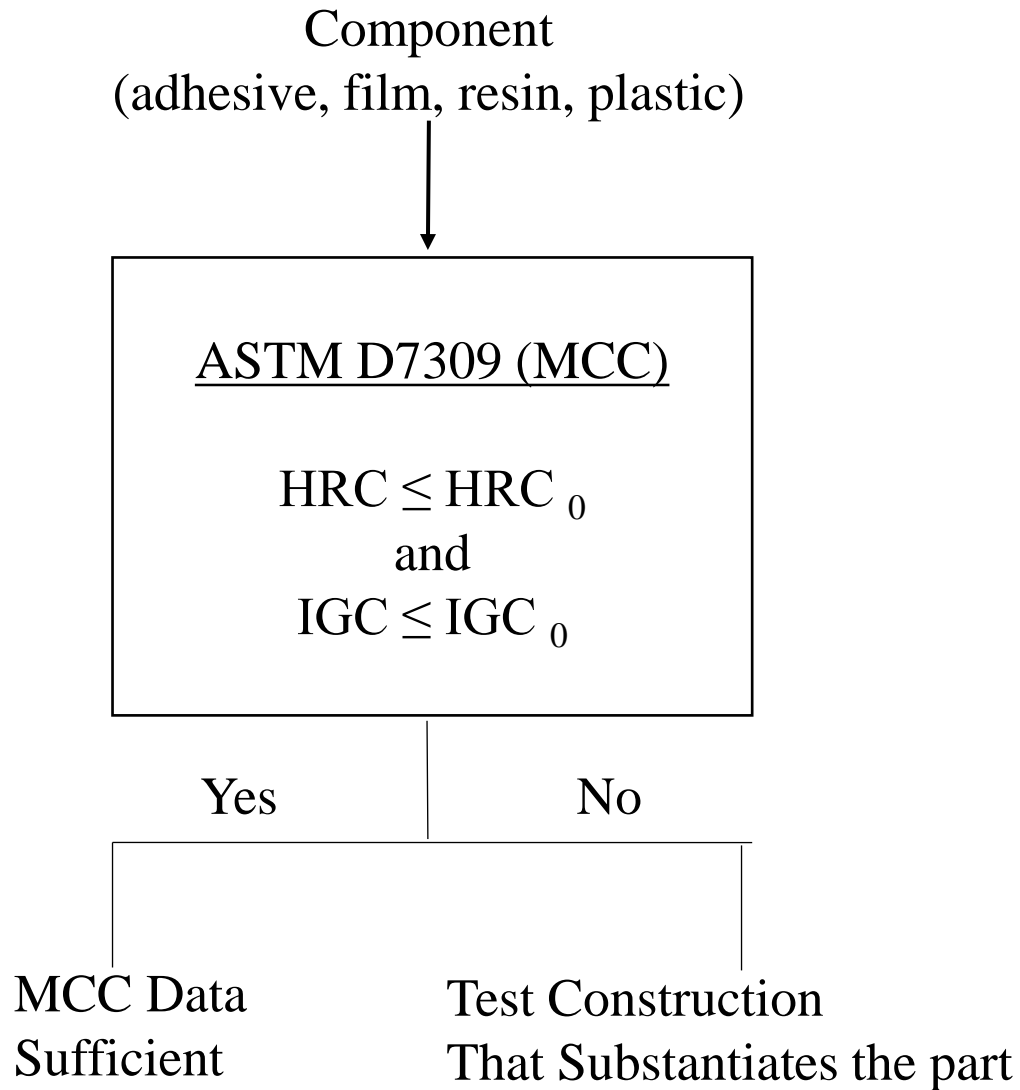
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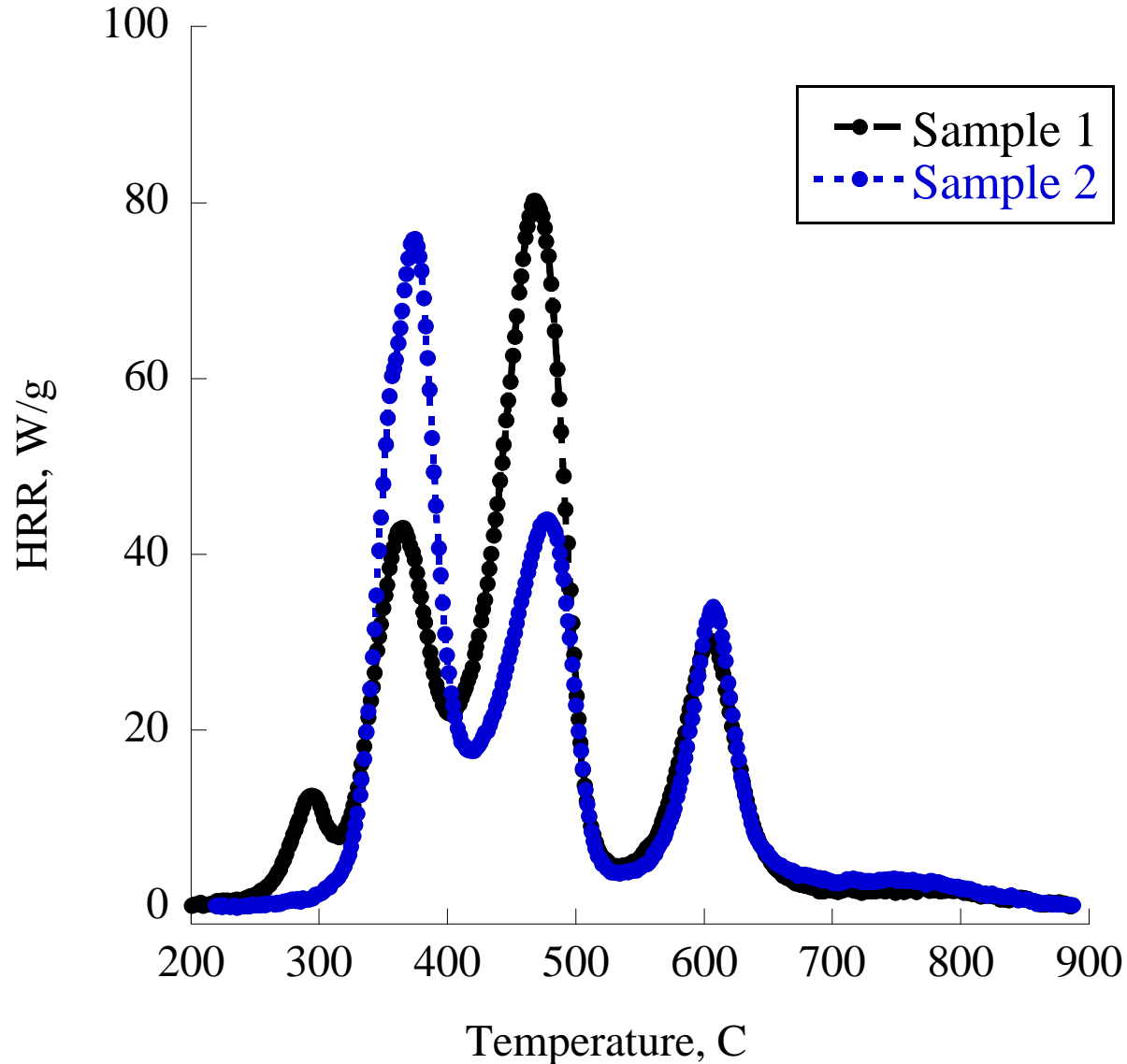
# Approach



- Decision flow chart includes 2 criteria HRC and IGC
- HRC is heat release capacity, defined as peak heat release rate divided by heating rate
- IGC is ignition capacity, defined as total heat released divided by delta T of ignition temperature and room temperature.
- The materials are considered to be **"Similar"** at the **95% confidence level** if the mean values of the MCC or FAR test results are within 2 standard deviations of each other.



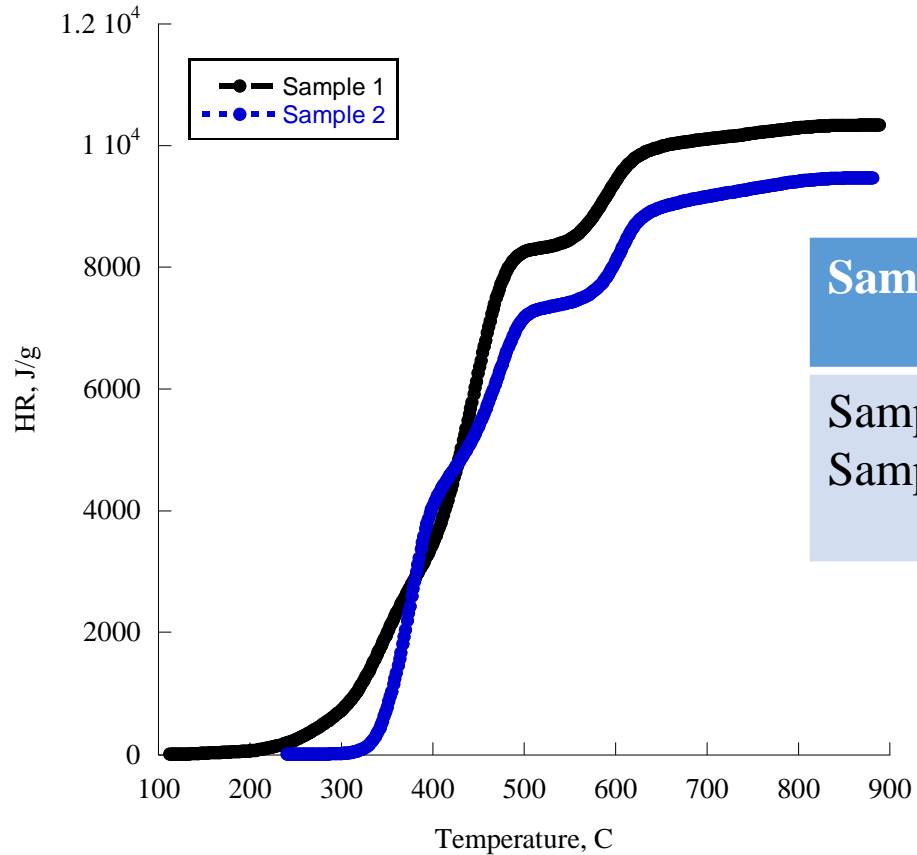
# Case study # 1 : Films



## *Procedure:*

- *Obtain max value for HRR*
- *Integrate HRR vs time (curve)*
- *Obtain max value for integral curve*
- *Obtain  $T_{ign}$  using extrapolated onset method from integral curve*
- *Determine HRC*
- *Determine IGC*

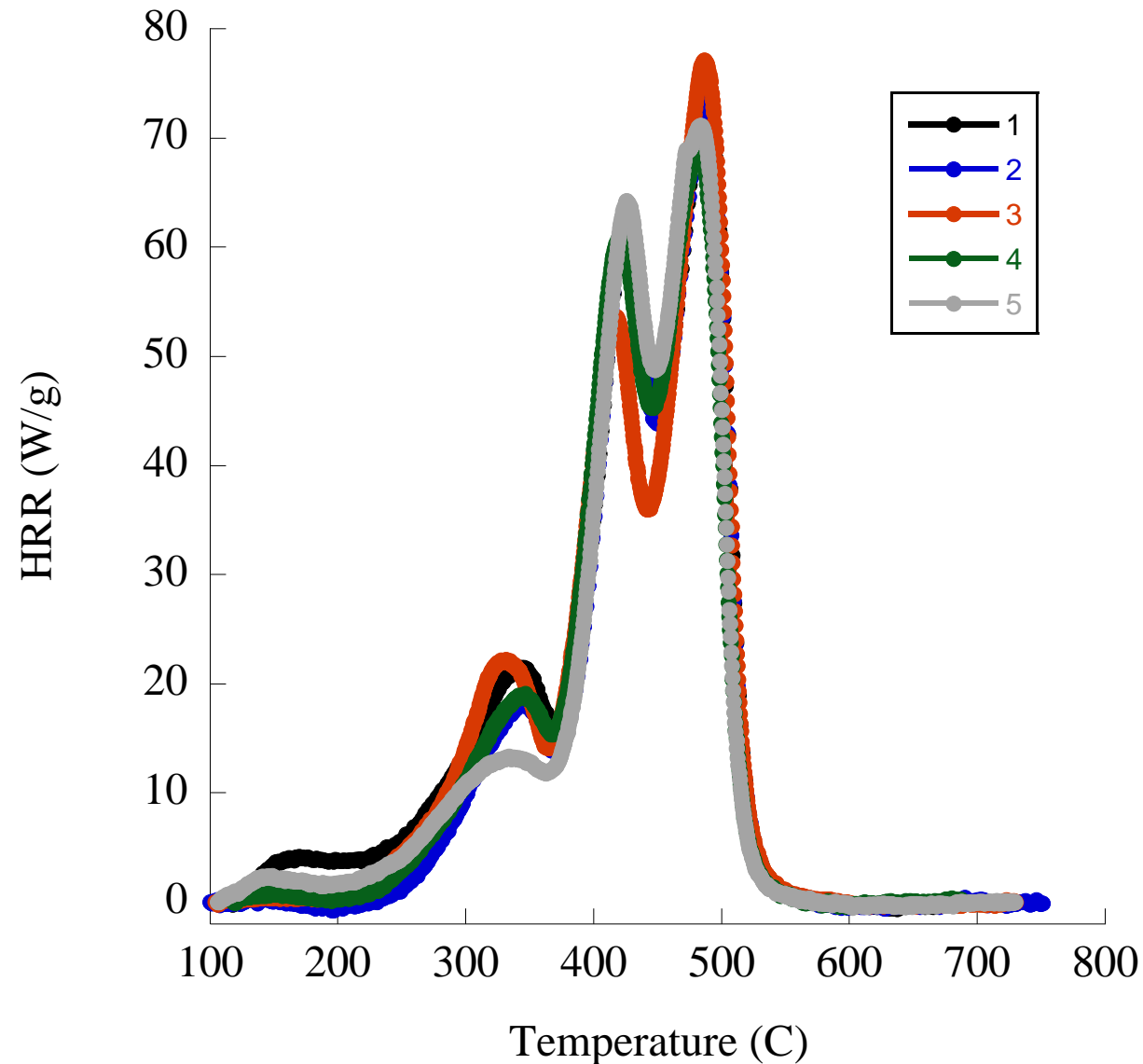
# Case study # 1 : Films (continued)



Sample	HR, kJ/g	T ign, C	HRC, J/g-K	IGC, J/g-K	MCC result	FAR result
Sample 1	10.4 ± 0.2	318 ± 10	76 ± 5	35 ± 1	Different	Different
Sample 2	9 ± 0.0.6	340 ± 2	77 ± 4	28 ± 2		

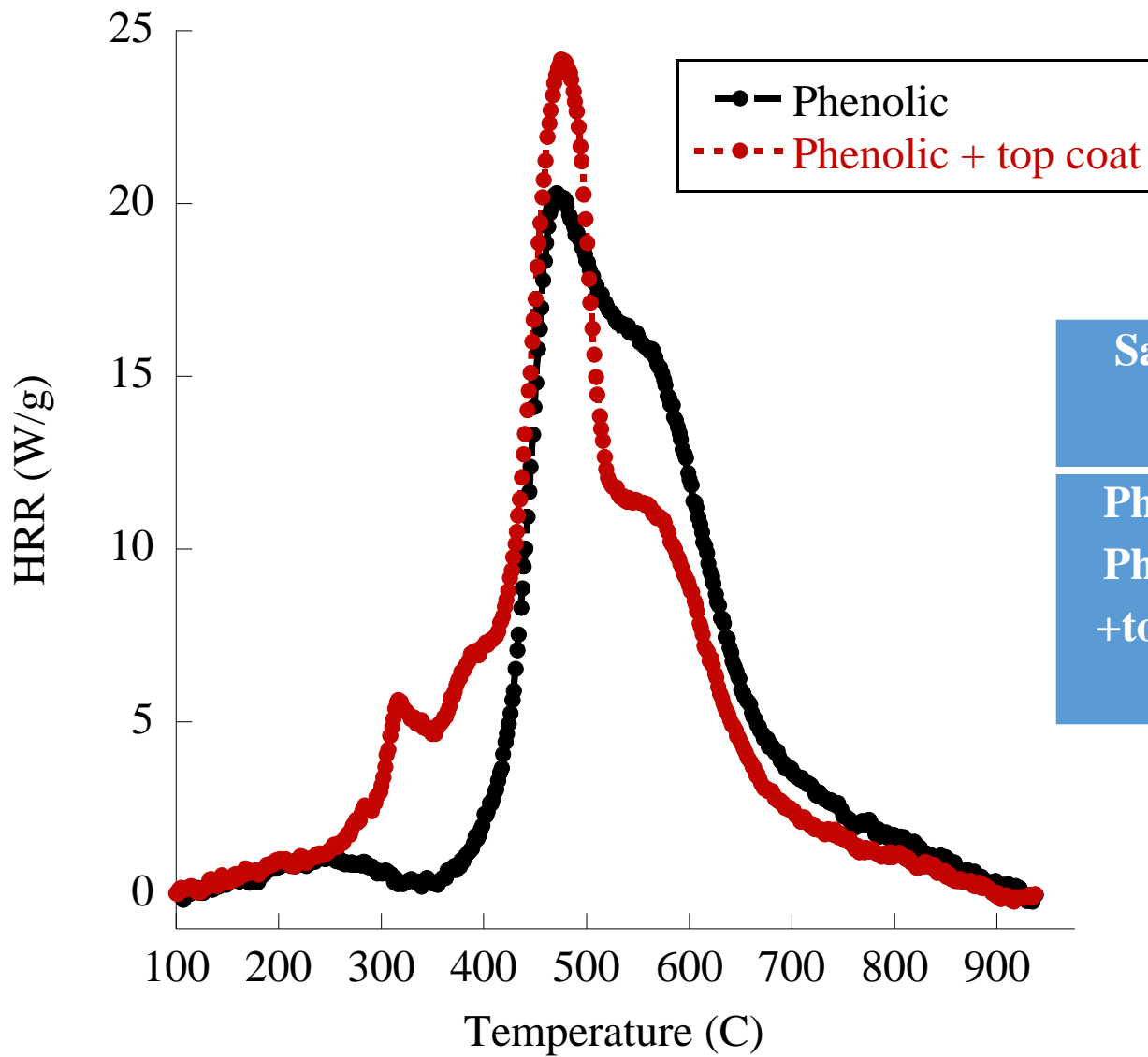
# Case study # 2 : Paints

Paint comparison



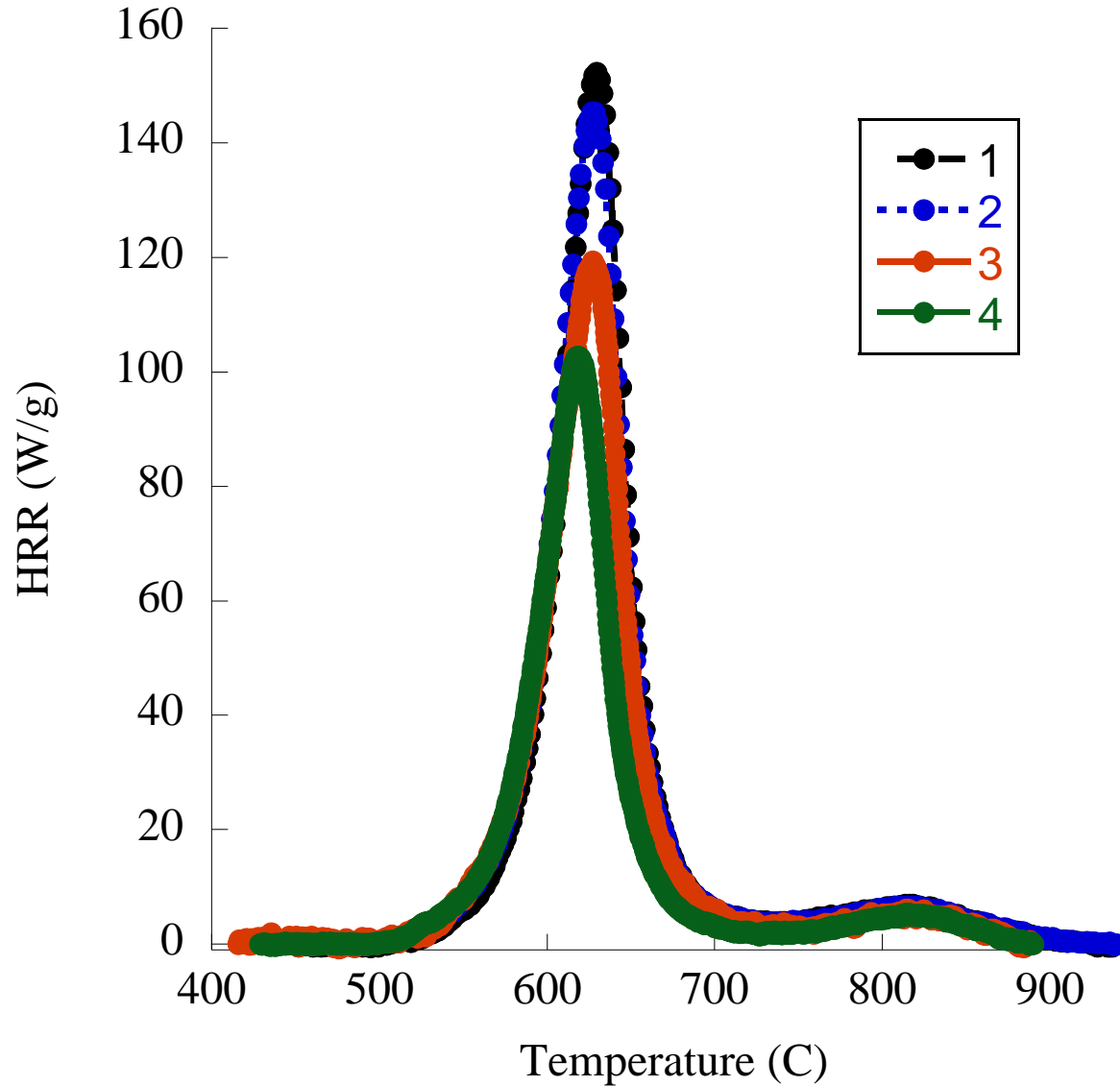
Sample	HRC, J/g-K	IGC, J/g-K	MCC result	pHRR, kW/m <sup>2</sup>	<sup>2</sup> min HR, kW*min/ m <sup>2</sup>	OSU Result
1	75 ± 1	36 ± 3	Similar	9 ± 1	5 ± 3	Similar
2	73 ± 1	34 ± 1		9 ± 1	6 ± 2	
1	75 ± 1	36 ± 3	Similar	9 ± 1	5 ± 3	Similar
3	79 ± 2	36 ± 4		13 ± 1	8 ± 1	
1	75 ± 1	36 ± 3	Similar	9 ± 1	5 ± 3	Similar
4	71 ± 2	33 ± 0		9 ± 2	5 ± 3	
1	75 ± 1	36 ± 3	Similar	9 ± 1	5 ± 3	Similar
5	72 ± 1	35 ± 2		9 ± 2	4 ± 2	
2	73 ± 1	34 ± 1	Similar	9 ± 2	6 ± 2	Similar
3	79 ± 2	36 ± 4		13 ± 1	8 ± 1	
2	73 ± 1	34 ± 1	Similar	9 ± 2	6 ± 2	Similar
4	71 ± 2	33 ± 0		9 ± 2	5 ± 3	
2	73 ± 1	34 ± 1	Similar	9 ± 2	6 ± 2	Similar
5	72 ± 1	35 ± 2		9 ± 2	4 ± 2	
3	79 ± 2	36 ± 4	Similar	13 ± 1	8 ± 1	Similar
4	71 ± 2	33 ± 0		9 ± 2	5 ± 3	
3	79 ± 2	36 ± 4	Different	13 ± 1	8 ± 1	Similar
5	72 ± 1	35 ± 2		9 ± 2	4 ± 2	
4	71 ± 2	33 ± 0	Similar	9 ± 2	5 ± 3	Similar
5	72 ± 1	35 ± 2		9 ± 2	4 ± 2	

# Case study # 3 : Phenolic/fiberglass



Sample	HRC	IGC	MCC result	Peak HRR	2 min HR	OSU result
Phenolic	20 ± 1	10 ± 3		68 ± 6	44 ± 6	
Phenolic +top coat	24 ± 1	15 ± 1	Similar	72 ± 3	60 ± 6	Similar

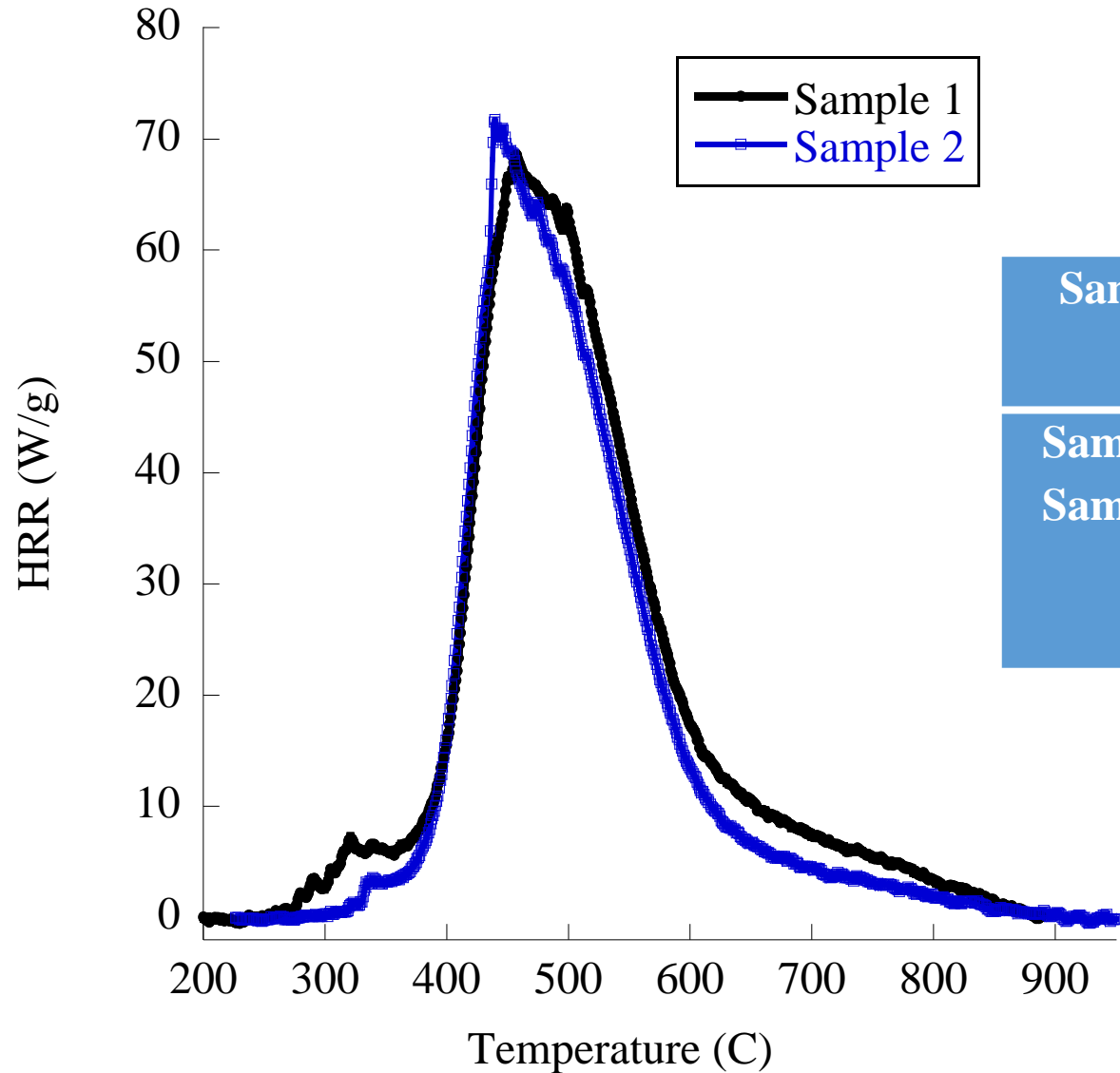
# Case study # 4 : PPSU



sample	HRC	IGC	MCC result	HRR	HR 2 min	OSU result
1	148 ± 4	16 ± 1	Similar	34 ± 3	4 ± 2	Similar
2	147 ± 3	17 ± 0		43 ± 14	4 ± 1	
1	148 ± 4	16 ± 1	Different	34 ± 3	4 ± 2	Similar
3	119 ± 4	14 ± 1		40 ± 6	9 ± 5	
1	148 ± 4	16 ± 1	Different	34 ± 3	4 ± 2	Similar
4	100 ± 7	12 ± 1		48 ± 9	6 ± 3	
2	147 ± 3	17 ± 0	Different	43 ± 14	4 ± 1	Similar
3	119 ± 4	14 ± 1		40 ± 6	9 ± 5	
2	147 ± 3	17 ± 0	Different	43 ± 14	4 ± 1	Similar
4	100 ± 7	12 ± 1		48 ± 9	6 ± 3	
3	119 ± 4	14 ± 1	Similar	40 ± 6	9 ± 5	Similar
4	100 ± 7	12 ± 1		48 ± 9	6 ± 3	



# Case study # 5 : Pregpeg with additive



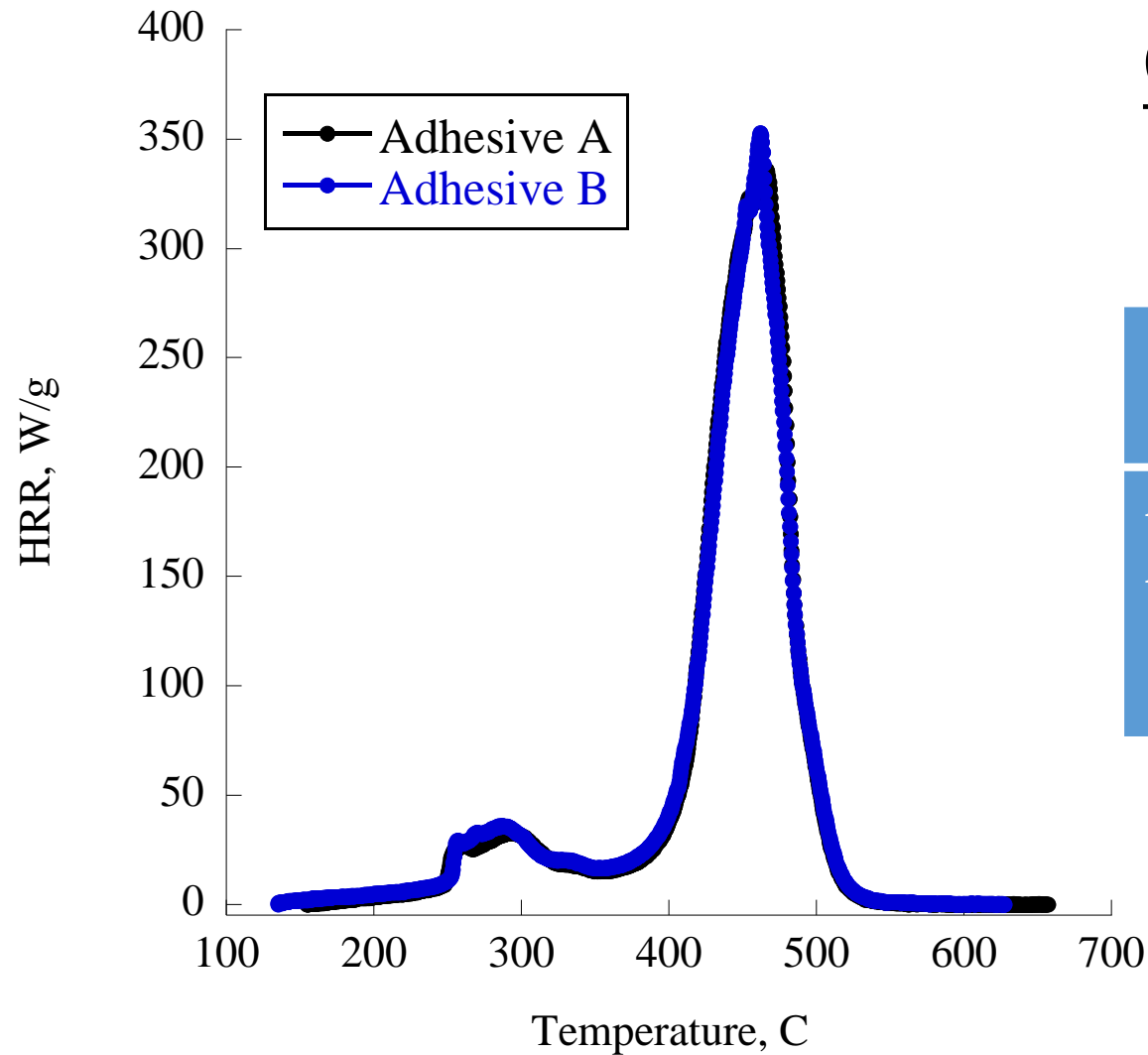
Sample	HRC	IGC	MCC result	Peak HRR	2 min HR	OSU result
Sample 1	66 ± 2	31 ± 2	Similar	20 ± 6	12 ± 3	Similar
Sample 2	67 ± 4	27 ± 2		17 ± 7	12 ± 4	

*\*Prepreg with new additive, sample set from 2015*



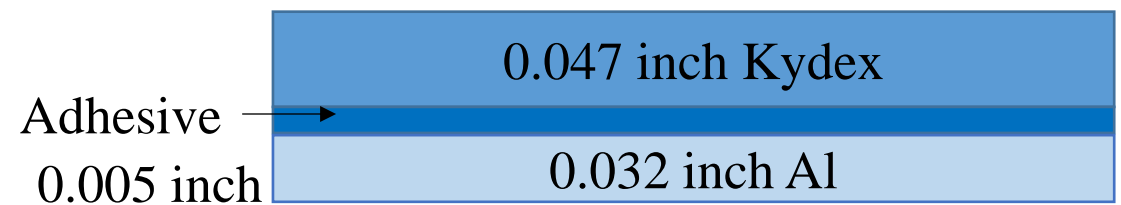


# Case study # 6 : Adhesive



Sample	HRC	IGC	MCC result	Peak HRR	2 min HR	OSU result
Adhesive A	331 ± 6	100 ± 6		52 ± 2	64 ± 4	
Adhesive B	335 ± 16	99 ± 3	Similar	54 ± 2	72 ± 3	Similar

## OSU test configuration:



## MCC test:



\*Adhesive with minor formulation change, sample set from 2015

# Conclusions



- MCC was proposed as a method to determine similarity at the material level of changes to certified materials.
- MCC guidance document was presented on FAA website on June 2016.
- Changes to criteria and approach were proposed in 2017.
- Six case studies were conducted for various components ( adhesives, phenolic, prepregs, films and PPSU ) in this project. In most cases, MCC test results for components were compared to OSU test results for constructions.
- MCC test method is more discriminating than OSU.