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The background of the slide is a long-exposure photograph of a city at night. In the foreground, a complex multi-level highway interchange is visible, with light trails from cars creating streaks of white and red. The background is filled with a dense skyline of skyscrapers, many of which are brightly lit with various colors like blue, yellow, and red. The overall scene conveys a sense of modern technology and urban infrastructure.

# Micro Combustion Calorimetry (MCC) as a Characterization Tool for Fire Resistant Adhesives

Eumi Pyun Ph.D. 3M CRML  
Patrick G. Zimmerman Ph.D. 3M AASD



# Agenda

**Materials Application Areas**

**Introduction to Micro Combustion Calorimetry (MCC)**

**Industry Characterization Method: Vertical Bunsen Burner(VBB)**

**Why MCC vs. VBB**

**VBB Configuration Materials Testing & Results**

**MCC of non Fire Resistant (FR) Materials**

**MCC of FR Materials**

**MCC of Fire Smoke & Tox (FST)**

**MCC of Experimental FR Materials**

**Reproducibility of MCC**

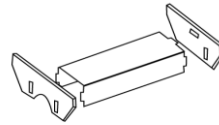
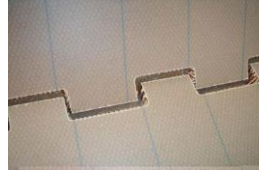
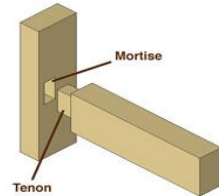
**Conclusions/Next Steps**

**References/Acknowledgements**

# Application Areas for FR Adhesives/Pastes

## Applications

- Bonding Panels
- Edge Filling Panels
- Potting Core
- Potting Inserts



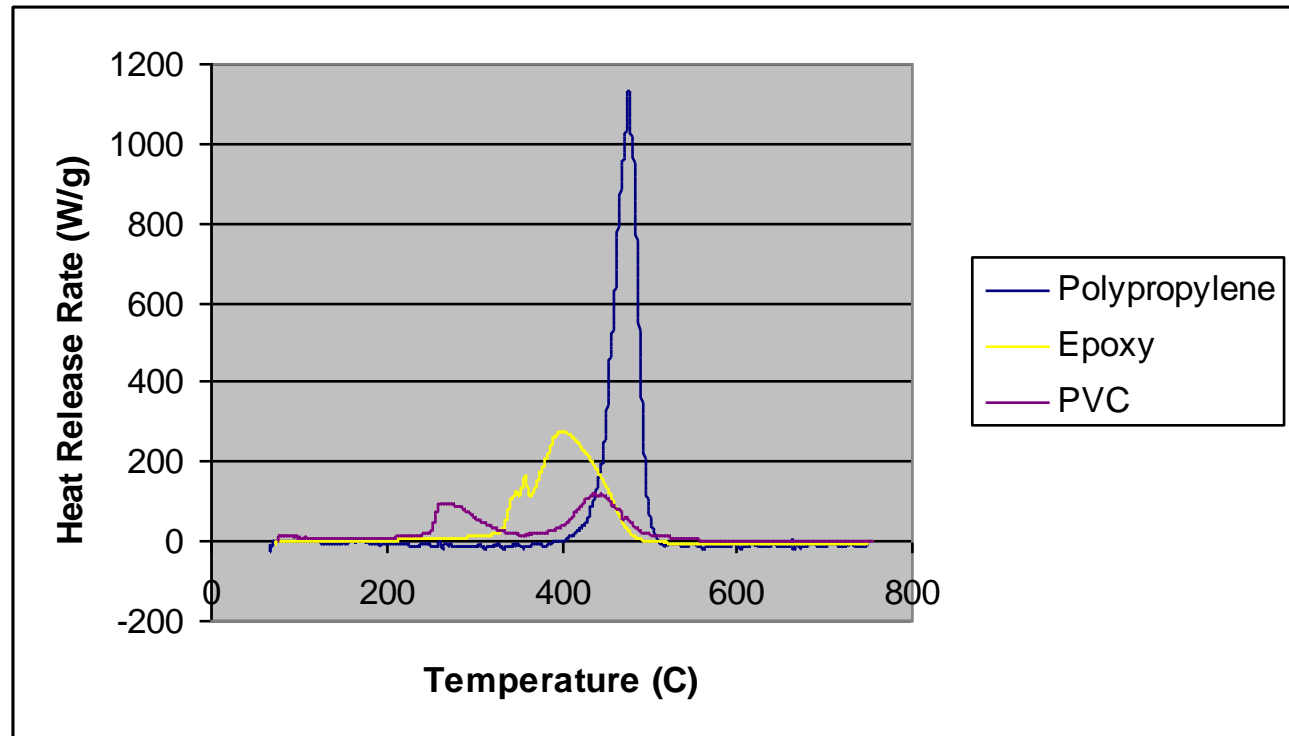
## Monuments

- Galleys
- Lav's
- Crew Rests
- Stow Bins
- Cargo Panels
- Carts
- Dog Houses
- Interior Walls & Ceiling



# Microcombustion Calorimeter (MCC)<sup>3,4</sup>

## Pyrolysis Combustion Flow Calorimeter (PCFC)



MCC Testing only Requires microgram Quantities

# MCC/PCFC

- **The Pyrolysis Combustion Flow Calorimeter is an oxygen consumption calorimeter instrument.**
  - **Developed by Rich Lyon/Rich Walters of the Federal Aviation Administration.**
  - **3M CRML was part of the early round robin testing conducted by the FAA.**
  - **Small scale flammability test of 0.5 to 50mg of material.**
  - **This instrument has been validated by ASTM and the publication is ASTM D7309.**
- **Measures:**
  - **Heat Release Capacity (HRC) (J/g-K)**
  - **Total Heat Release (THR)(kJ/g)**
  - **In effect – a rapid quantitative test for material flammability.**

# Vertical Bunsen Burner (VBB)<sup>1</sup>

## Developed to Determine Material Fire (Propagation) Resistance

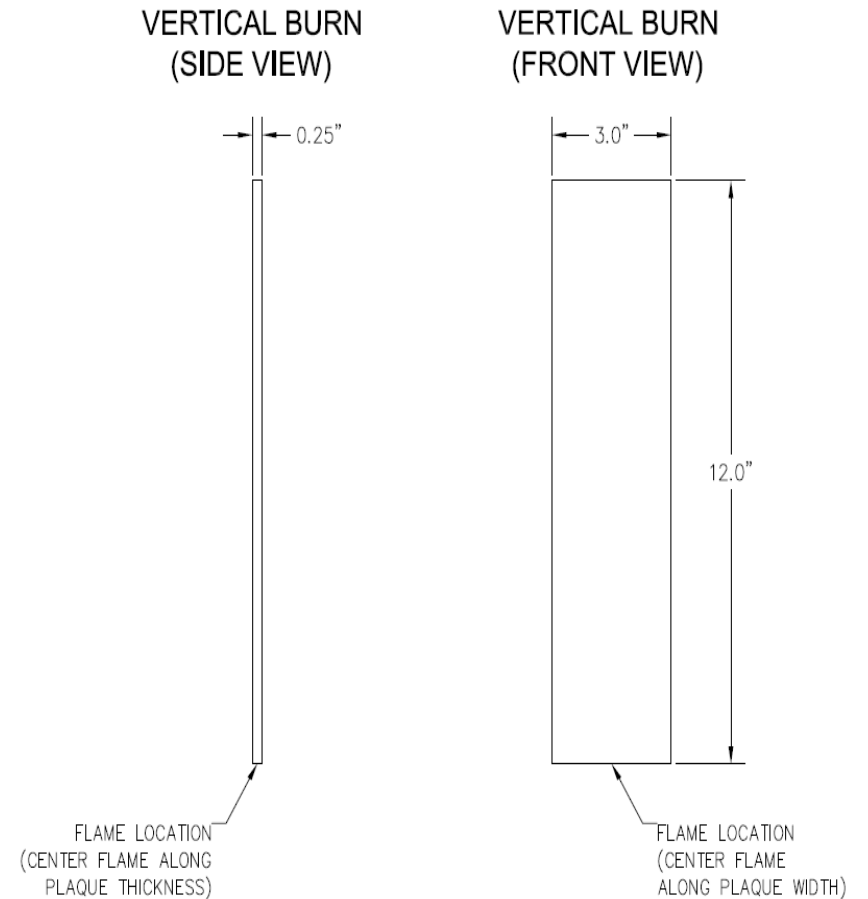
- 12 Second Flame Test
- Material Pass if:
  - Self extinguish in 15 sec or less
  - Propagation of flame 8" or less
  - Replicates: Either
    - 3 passing or
    - 80% of larger number

## All Samples Tested as Plaque<sup>2</sup>

- Dimensions 0.625cm x 7.5cm x 30cm
- Requires 50-120g of material/plaque

## All VBB Samples tested by **3M**

- Tested on a Marlin ME1000 Test Chamber



# MCC and VBB Comparison

## MCC

**Sample Prep Time with Base Resin**

**Fast Multiple Formulations**

**Easy Test Format/formulation**

**Test Requirements:**

**Low quantities, micro-gram**

**Small Sample Size**

**Operator independent**

**Burn Characterization**

**10 min/specimen**

## VBB

**Sample Prep Time with Base Resin**

**Slow Multiple Formulations**

**Multiple Large Plaques/formulation  
(5-10 min/plaque, 3x minimum)**

**Test Requirements**

**75-150 grams/plaque**

**Large: 0.625 cm x 7.5 cm x 30 cm**

**Some operator dependence**

**Burn Characterization**

**1 minute/specimen Minimum 3 min**

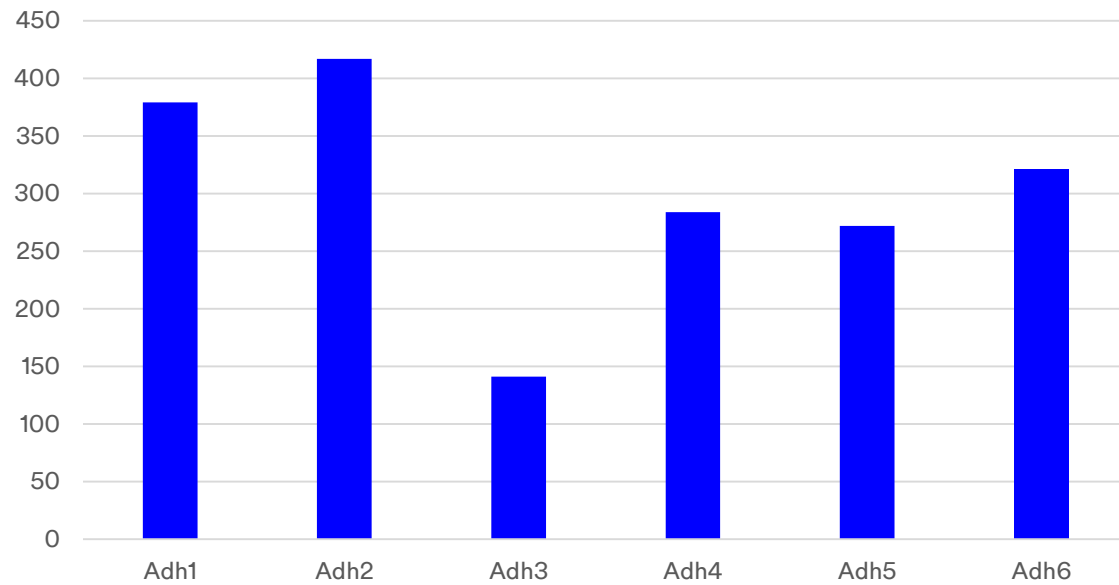
# VBB Sample Results <sup>5</sup>

		12 Sec VBB		
Specimen Designation	FR Type	After Burn (sec)	Burn Length (inches)	Pass/Fail
Adh1	None	120	12	Fail
Adh2	None	120	12	Fail
Adh3	None	45	7.5	2 Pass, 1 Fail
Adh4	None	120	12	Fail
Adh5	None	120	12	Fail
Adh6	None	120	12	Fail
FR1	FR	1	0.5	Pass
FR2	FR	1	2	Pass
FR3	FR	2	2	Pass
FR4	FR	1	2	Pass
FST 1	FST	0	0.5	Pass
FST2	FST	1.5	1	Pass
FST3	FST	2.8	1	Pass

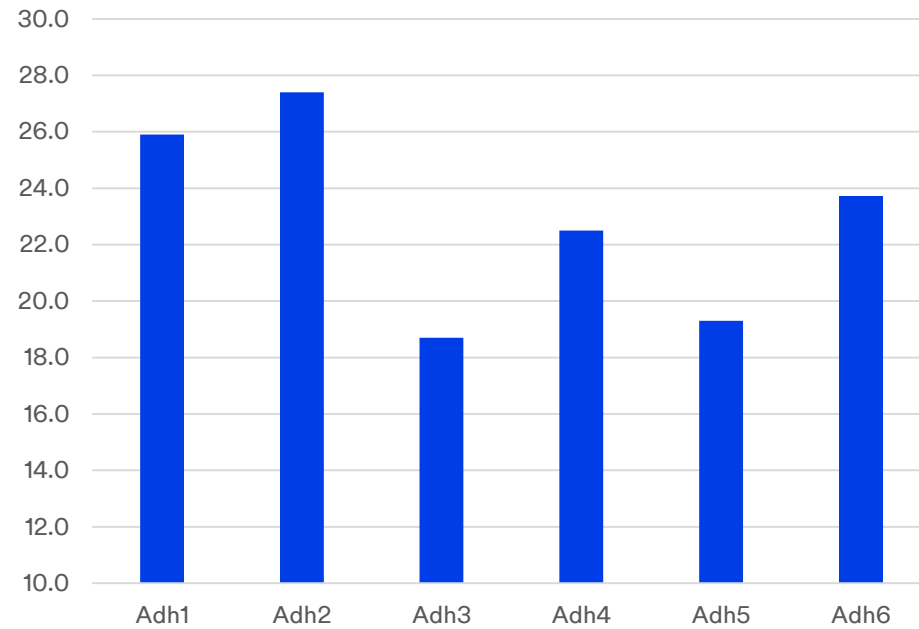


# MCC of Non-FR Adhesives

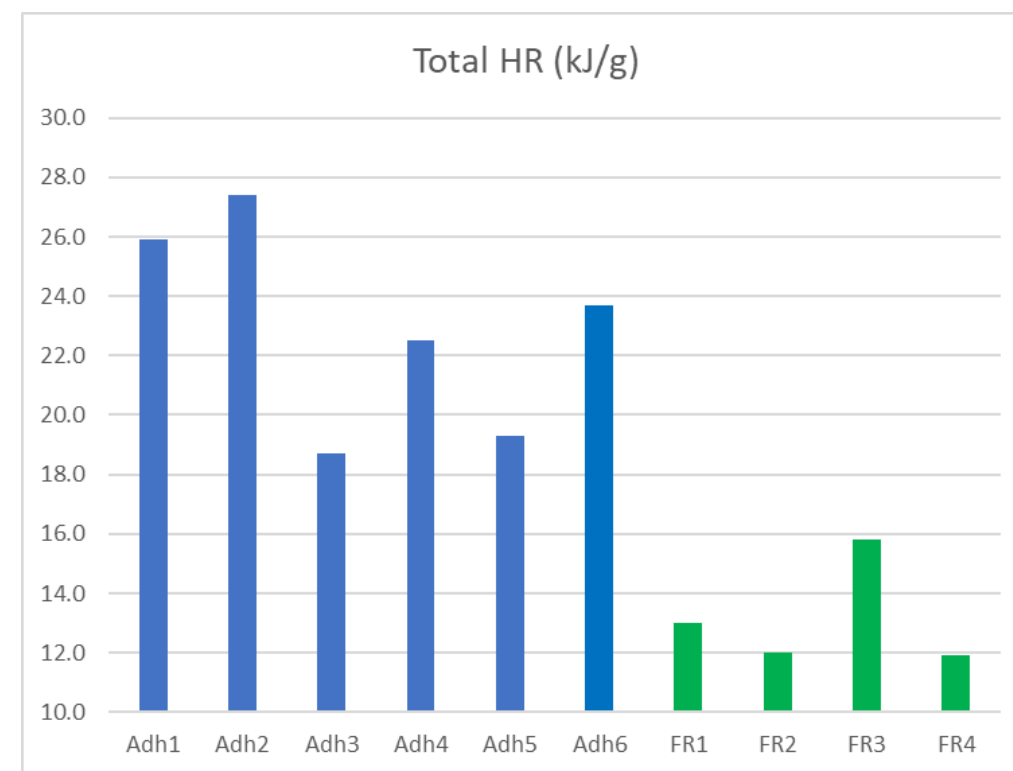
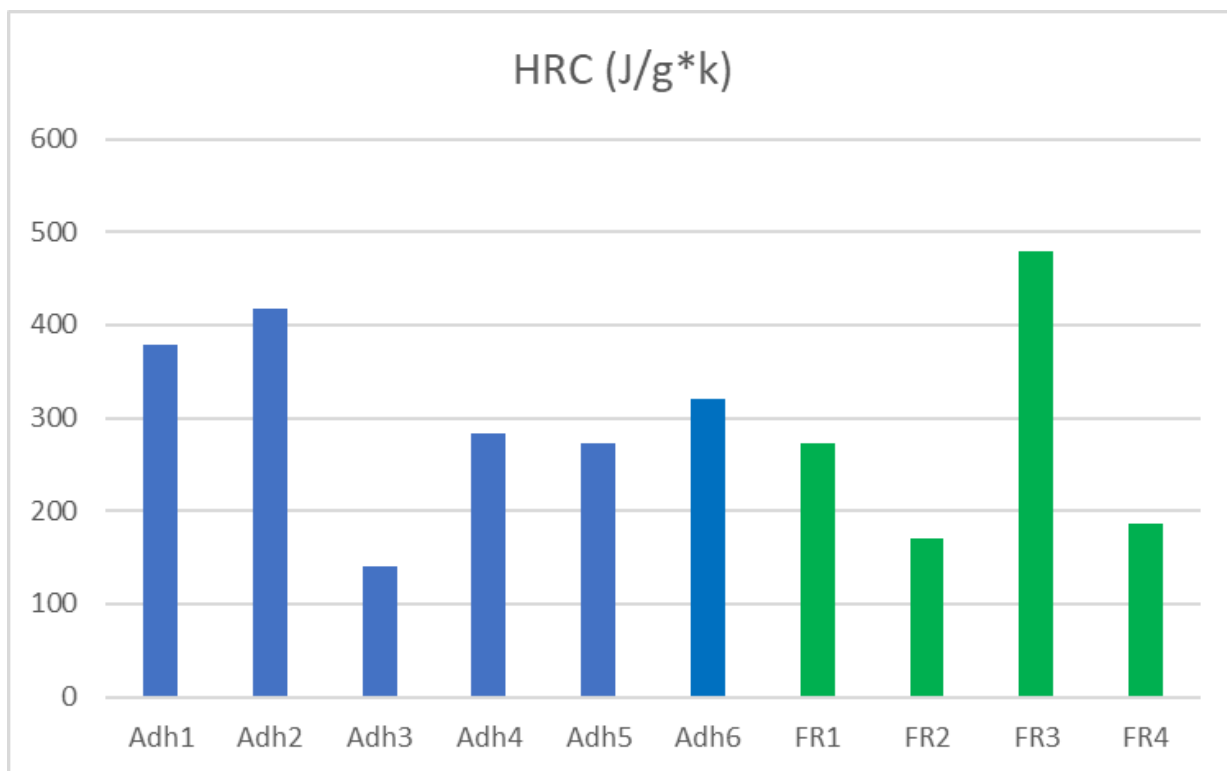
HRC (J/g\*k)



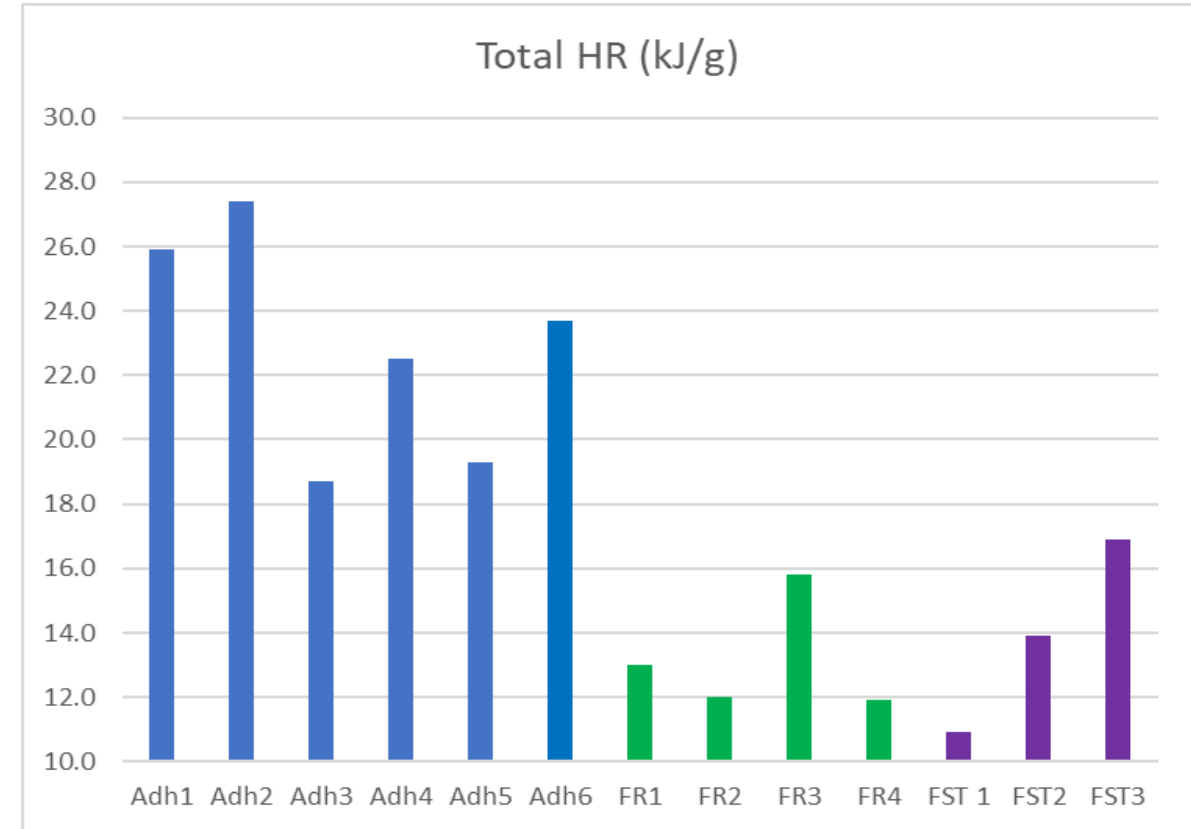
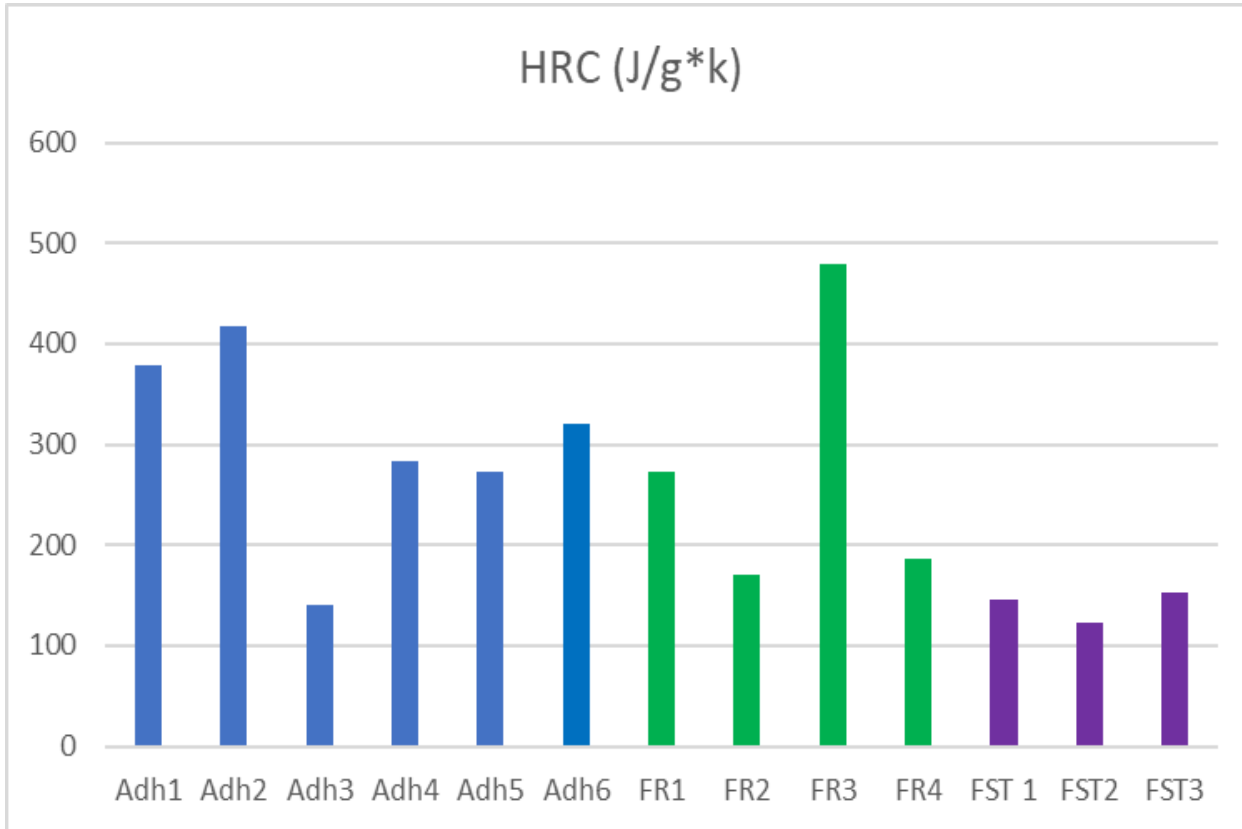
Total HR (kJ/g)



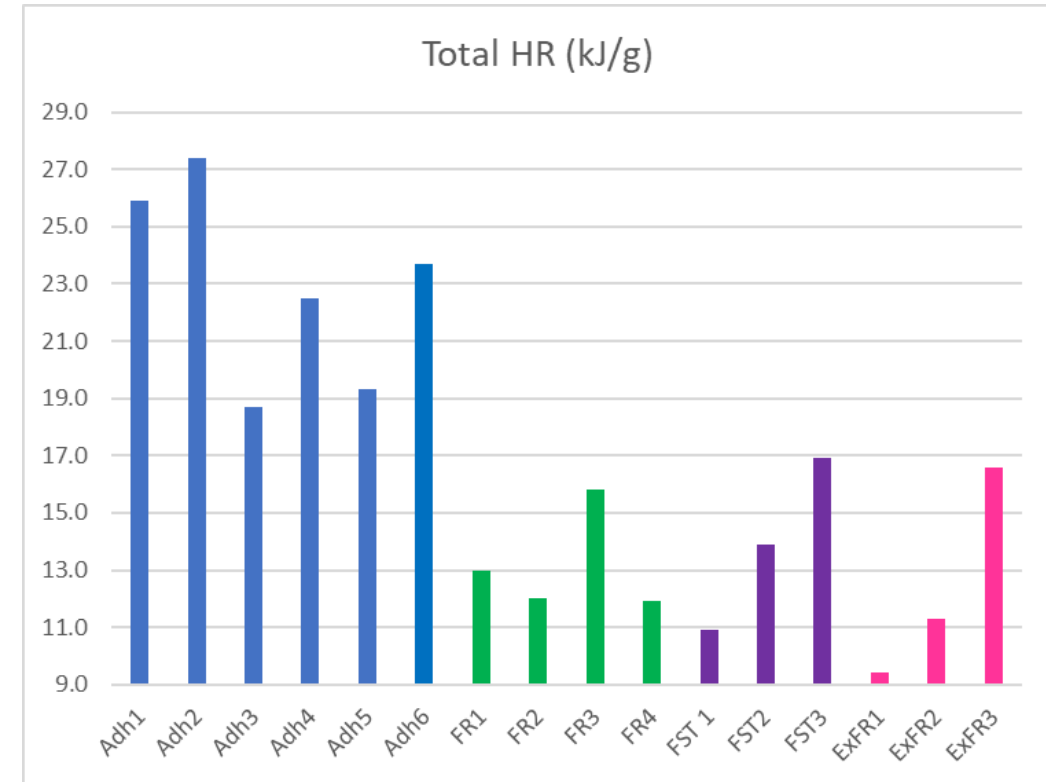
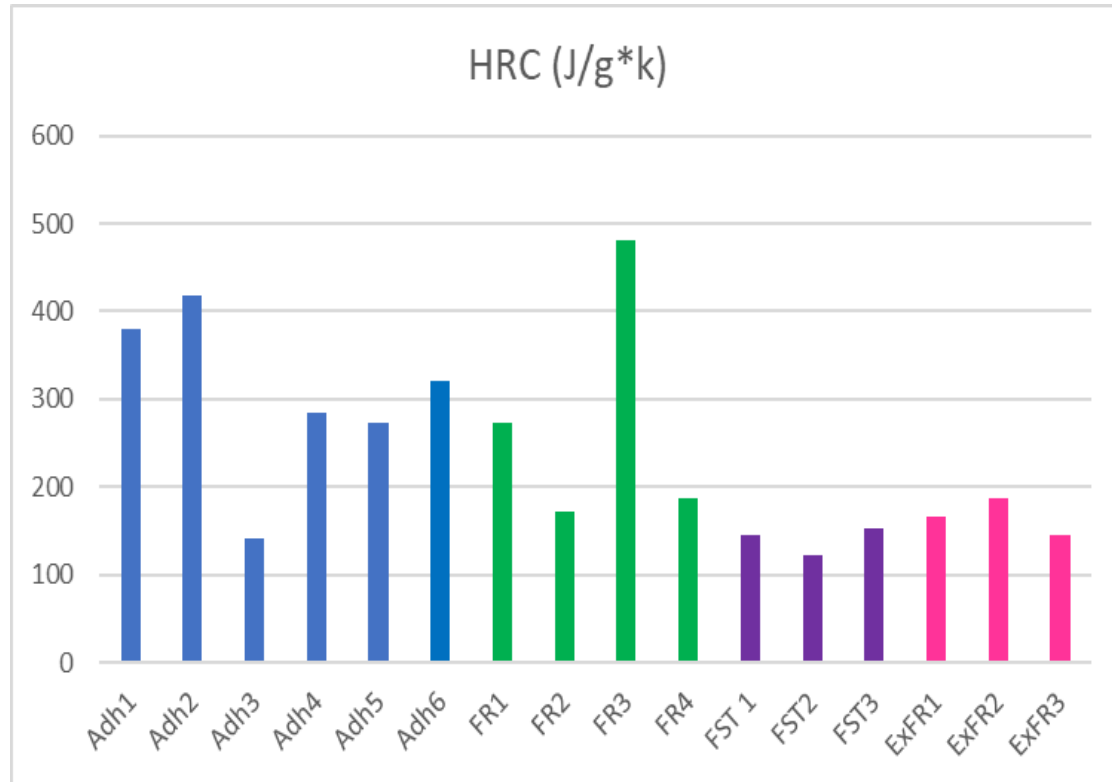
# MCC of Non FR & FR Adhesives



# MCC of Non-FR, FR & FST Adhesives

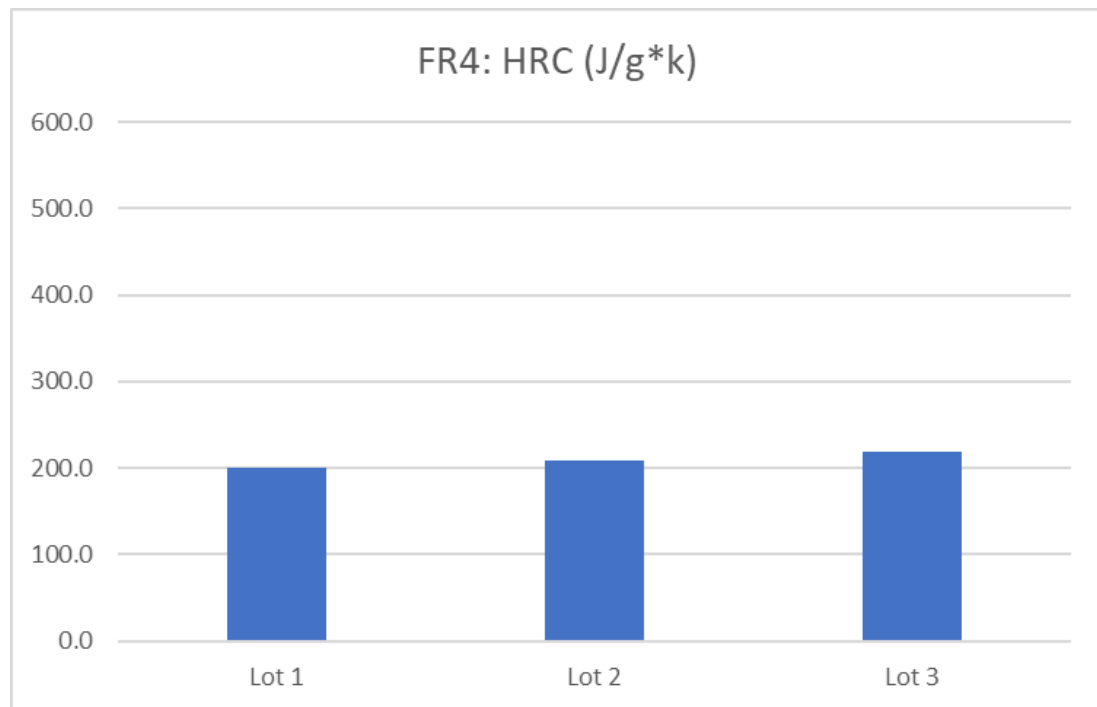


# MCC of Non-FR, FR,FST & Experimental Adhesives

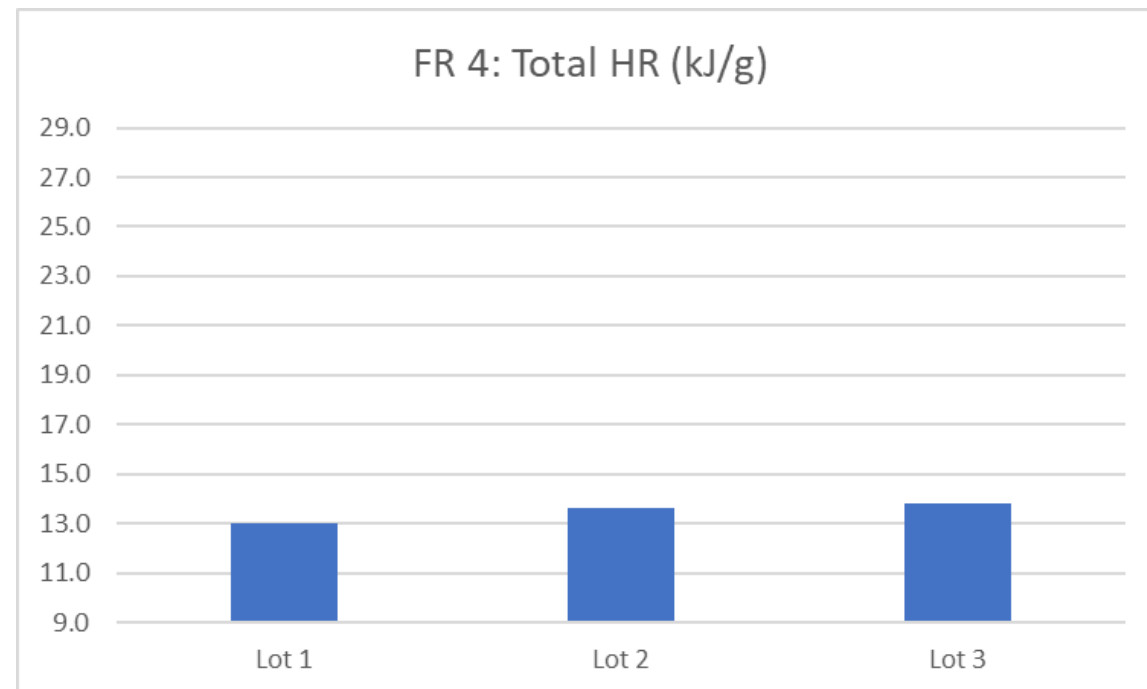




# MCC Reproducibility with FR4



Average: 208 +/-12J/g\*k



Average: 13.4 +/-0.7kJ/g

## **Conclusions**

- 1. MCC shows better correlation between THR and VBB FR results than HRC.**
- 2. Using THR as guidance, threshold for VBB FR is in range of 16kJ/g-18KJ/g.**
- 3. Using Microgram for MCC vs. 100's grams for VBB, MCC Shows Promise as Potential tool in formulation studies.**

## **Next Steps**

- 1. Determine importance of HRC, if any for 12 sec VBB**
- 2. Examine MCC as valid method for Pressure Sensitive Adhesives.**
- 3. Develop MCC “Sampling Method” for single Sided tapes.**
- 4. If Samples Method in 3 Successful, apply to other composite constructs.**

The background is a complex, abstract geometric pattern composed of numerous triangles of varying sizes and orientations. The color palette is a range of blues, from deep navy blue to bright cyan, creating a sense of depth and movement. The triangles are arranged in a way that they seem to radiate from various points, creating a dynamic and modern aesthetic.

**Thank You.**  
**Questions.**

## References

1. 14CFR 25.853
2. PS-ANM-25.853-01-R2 & References cited therein
3. ASTM D7309,
4. MCC Guidance Update Rev B (10-2018) & References cited therein
5. Each Material conducted 3 specimen plaques
6. FR tested to 14CFR 25.853 (a)
7. FST tested to 14 CFR25.853 (a) (d) & ABD-0031

## Acknowledgements

1. Dr. Richard Lyons FAA
2. Dr Alex Morgan UDRI
3. 3M Corporate Research Labs (MCC Testing)
4. 3M Automotive & Aerospace Solutions Division ( 12 Sec VBB)