Flame Retardants & Similarity of Material Changes

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International Materials Fire Test Working Group Meeting

Atlantic City, New Jersey, USA

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Federal Aviation Administration

Flame Retardants & Similarity of Material Changes

- Task Team Would be Industry-Chaired Cost Saving Initiative
- Supported by FAA

FAA Memorandum ANM-115-09
Policy Statement on Flammability Testing of Interior Materials

… the FAA is interested in developing a method so an adhesive used to join two parts can be qualified on its own and used to join any two parts. This would cover many of the items currently in category 2. The FAA is actively examining different adhesives [chemical compositions] and developing such a method. While the specific method is not yet defined, ***the FAA solicits comment on the approach, which would be an alternative to the methods shown for items 28-32 and 34-41.***

FAA Initiatives in Flame Retardant Replacements

- Demonstrate milligram-scale test to measure effectiveness of halogen flame retardant replacements in regulatory fire tests.
- Support similarity testing of cabin materials with substitute flame retardants.

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Acceptable Methods of Compliance

Configurations: Passing more difficult test (OSU > Foam Block > VB > HB) or more flammable configuration/worst case (color, density, thickness, texture, orientation, core cell size/density, etc.) *substantiates* all lesser tests and material configurations of the same chemical composition.

Compositions: If a change in the chemical composition of a certified configuration does not adversely impact the basis for its certification (substantiation), the new configuration is *similar*.

How can we tell if a change in the chemical composition does not adversely impact the results of the certification test (basis) without re-certifying the part?

Similarity

A certified Configuration A is *changed* to Configuration B.

From a certification standpoint, these configurations will be equivalent with regard to safety (similar) if the certification data that substantiates Configuration A also substantiates Configuration B.

In other words A and B are similar if the changes to A, whatever they are, do not impact the original basis for certification.

Flame Retardants and Material Changes

- *How can a small change (similarity) be demonstrated?*
- *Can fire properties of materials predict fire performance of configurations in FAA tests?*
- *Are fire properties of material combinations additive*, i.e.,

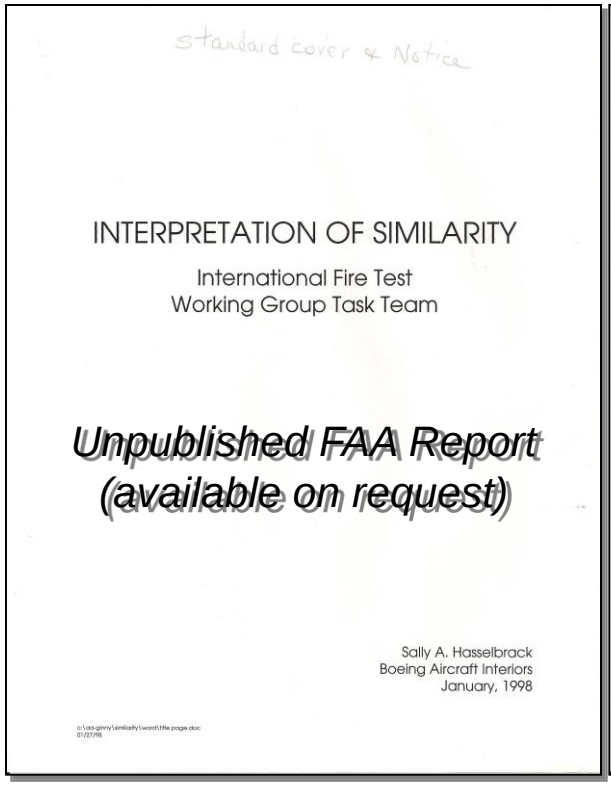
$$P_{ij} = P_i + P_j$$

- *Or, are there positive/negative interactions too*, e.g.,

$$P_{ij} = P_i + P_j \pm \lambda(P_i P_j)^{1/2}$$

1994-1998 Attempt to Evaluate Similarity Of Upholstery Materials in Oil Burner Test Was Inconclusive

- Upholstery: 5 fiber types/blends
- Fire Blockers: 6 fabric types
- Fire Hardened Foams: 8 densities
- Polyurethane foams: 5 densities

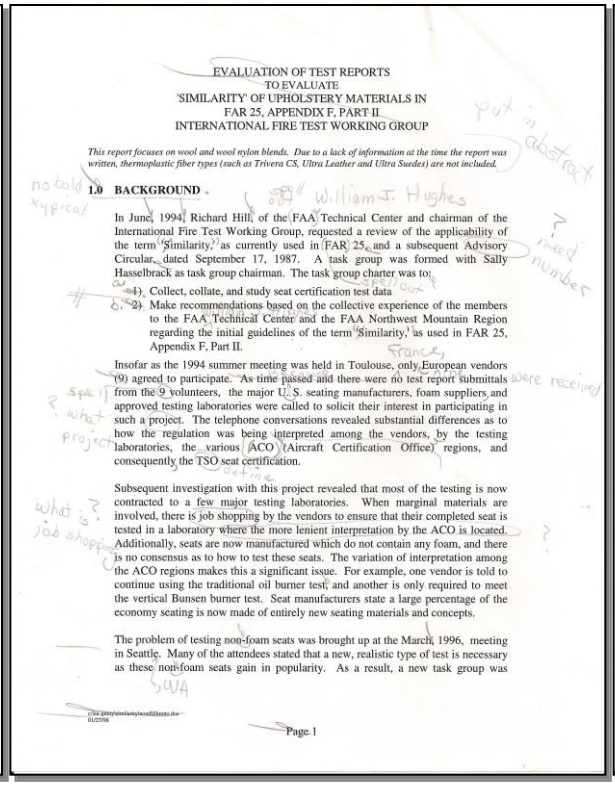


INTERPRETATION OF SIMILARITY

International Fire Test
Working Group Task Team

Unpublished FAA Report
(available on request)

Sally A. Hasselbrack
Boeing Aircraft Interiors
January, 1998



EVALUATION OF TEST REPORTS
TO EVALUATE
'SIMILARITY' OF UPHOLSTERY MATERIALS IN
FAR 25, APPENDIX F, PART II
INTERNATIONAL FIRE TEST WORKING GROUP

This report focuses on wool and wool nylon blends. Due to a lack of information at the time the report was written, thermoplastic fiber types (such as Trivera CS, Ultra Leather and Ultra Suedes) are not included.

1.0 BACKGROUND

In June, 1994, Richard Hill, of the FAA Technical Center and chairman of the International Fire Test Working Group, requested a review of the applicability of the term 'similarity,' as currently used in FAR 25, and a subsequent Advisory Circular, dated September 17, 1987. A task group was formed with Sally Hasselbrack as task group chairman. The task group charter was to:

1). Collect, collate, and study seat certification test data
2). Make recommendations based on the collective experience of the members to the FAA Technical Center and the FAA Northwest Mountain Region regarding the initial guidelines of the term 'similarity,' as used in FAR 25, Appendix F, Part II.

Insofar as the 1994 summer meeting was held in Toulouse, only European vendors (9) agreed to participate. As time passed and there were no test report submittals from the 9 volunteers, the major U. S. seating manufacturers, foam suppliers and approved testing laboratories were called to solicit their interest in participating in such a project. The telephone conversations revealed substantial differences as to how the regulation was being interpreted among the vendors, by the testing laboratories, the various ACO (Aircraft Certification Office) regions, and consequently the TSO seat certification.

Subsequent investigation with this project revealed that most of the testing is now contracted to a few major testing laboratories. When marginal materials are involved, there is job shopping by the vendors to ensure that their completed seat is tested in a laboratory where the more lenient interpretation by the ACO is located. Additionally, seats are now manufactured which do not contain any foam, and there is no consensus as to how to test these seats. The variation of interpretation among the ACO regions makes this a significant issue. For example, one vendor is told to continue using the traditional oil burner test, and another is only required to meet the vertical Bunsen burner test. Seat manufacturers state a large percentage of the economy seating is now made of entirely new seating materials and concepts.

The problem of testing non-foam seats was brought up at the March, 1996, meeting in Seattle. Many of the attendees stated that a new, realistic type of test is necessary as these non-foam seats gain in popularity. As a result, a new task group was

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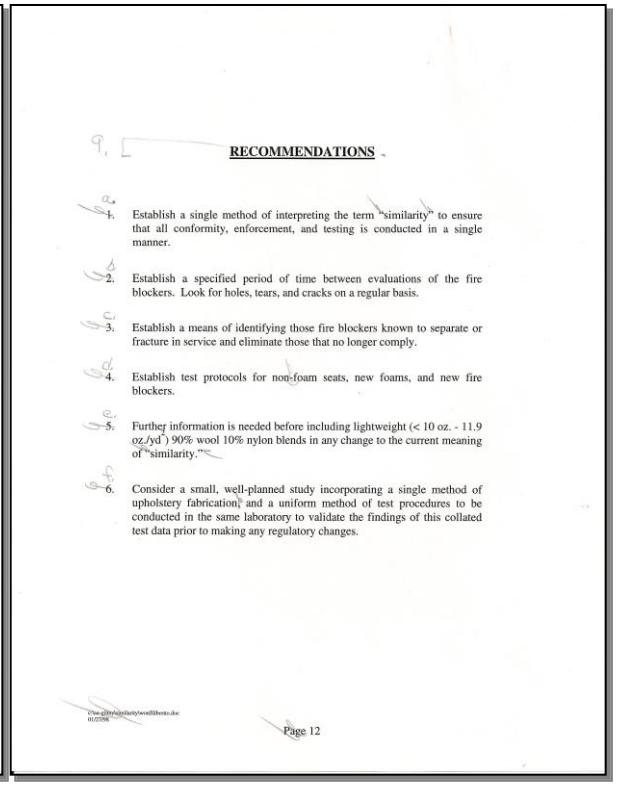

RECOMMENDATIONS

1. Establish a single method of interpreting the term "similarity" to ensure that all conformity, enforcement, and testing is conducted in a single manner.
2. Establish a specified period of time between evaluations of the fire blockers. Look for holes, tears, and cracks on a regular basis.
3. Establish a means of identifying those fire blockers known to separate or fracture in service and eliminate those that no longer comply.
4. Establish test protocols for non-foam seats, new foams, and new fire blockers.
5. Further information is needed before including lightweight (< 10 oz. - 11.9 oz./yd^2) 90% wool 10% nylon blends in any change to the current meaning of "similarity."
6. Consider a small, well-planned study incorporating a single method of upholstery fabrication, and a uniform method of test procedures to be conducted in the same laboratory to validate the findings of this collated test data prior to making any regulatory changes.

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5 x 6 x (8 or 5) = 390 possible combinations

Using Microscale Tests to Predict Bench/Full Scale Fire Test Results

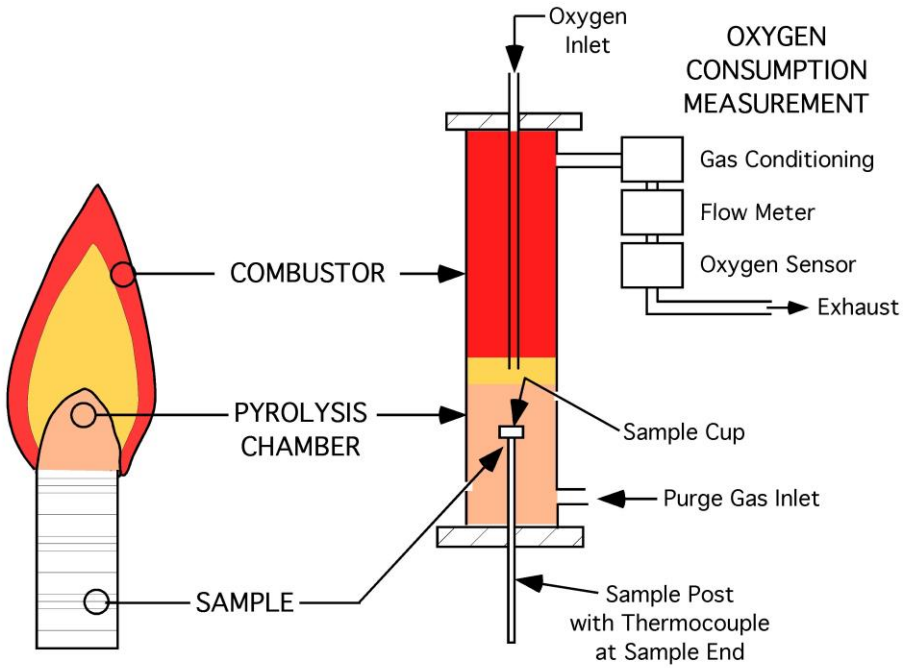
Under standard (ASTM D 7309) MCC conditions:

- Flame inhibition by brominated flame retardants in VBB and OSU tests is not captured (working on this).

- Small (milligram) samples may not be representative of bench/full-scale fire behavior (recent example to follow).

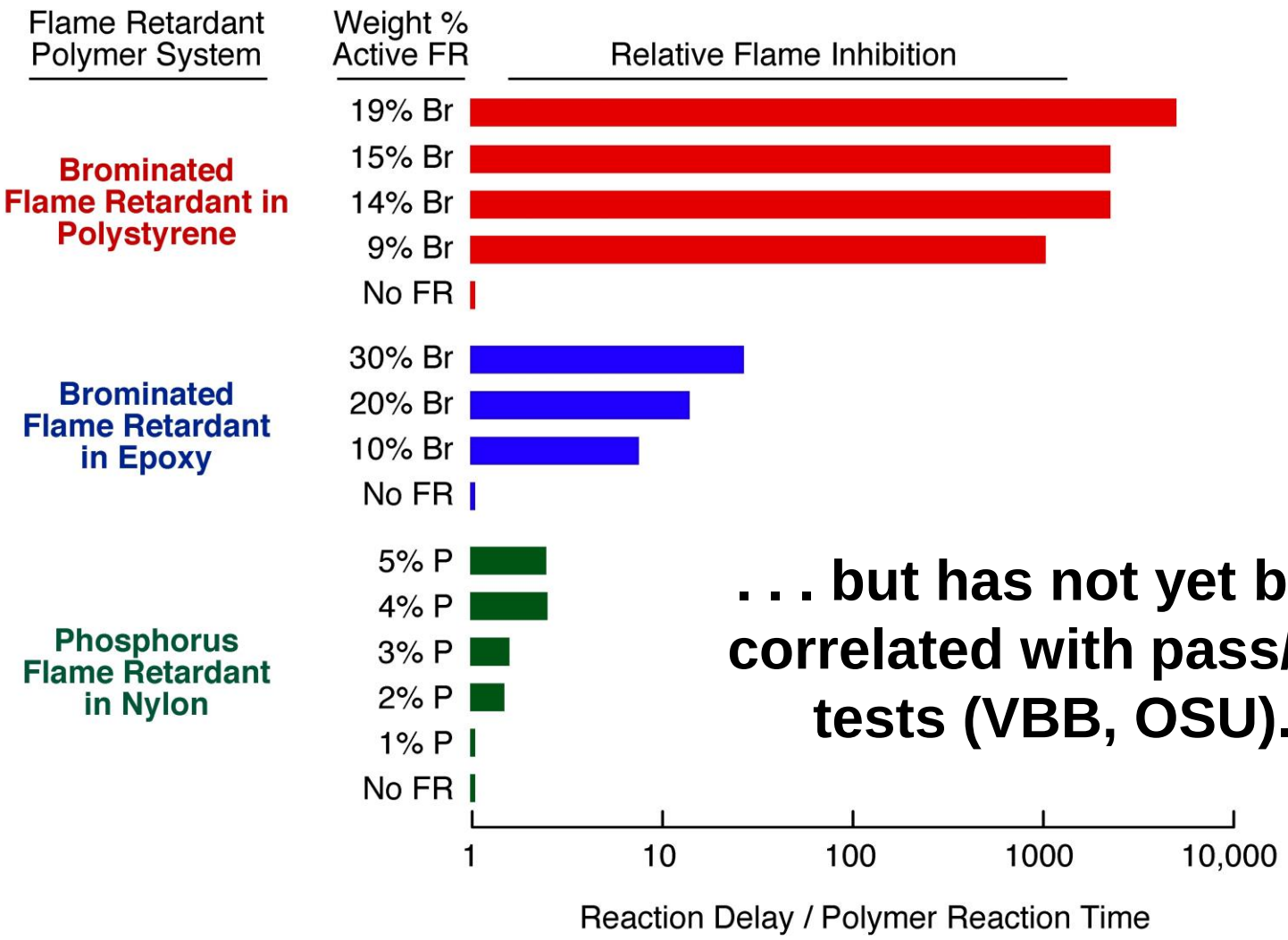
FAA
Microscale Combustion Calorimeter

- U.S. Patents 6,464,391 & 5,981,290
- ASTM Standard D7309-13



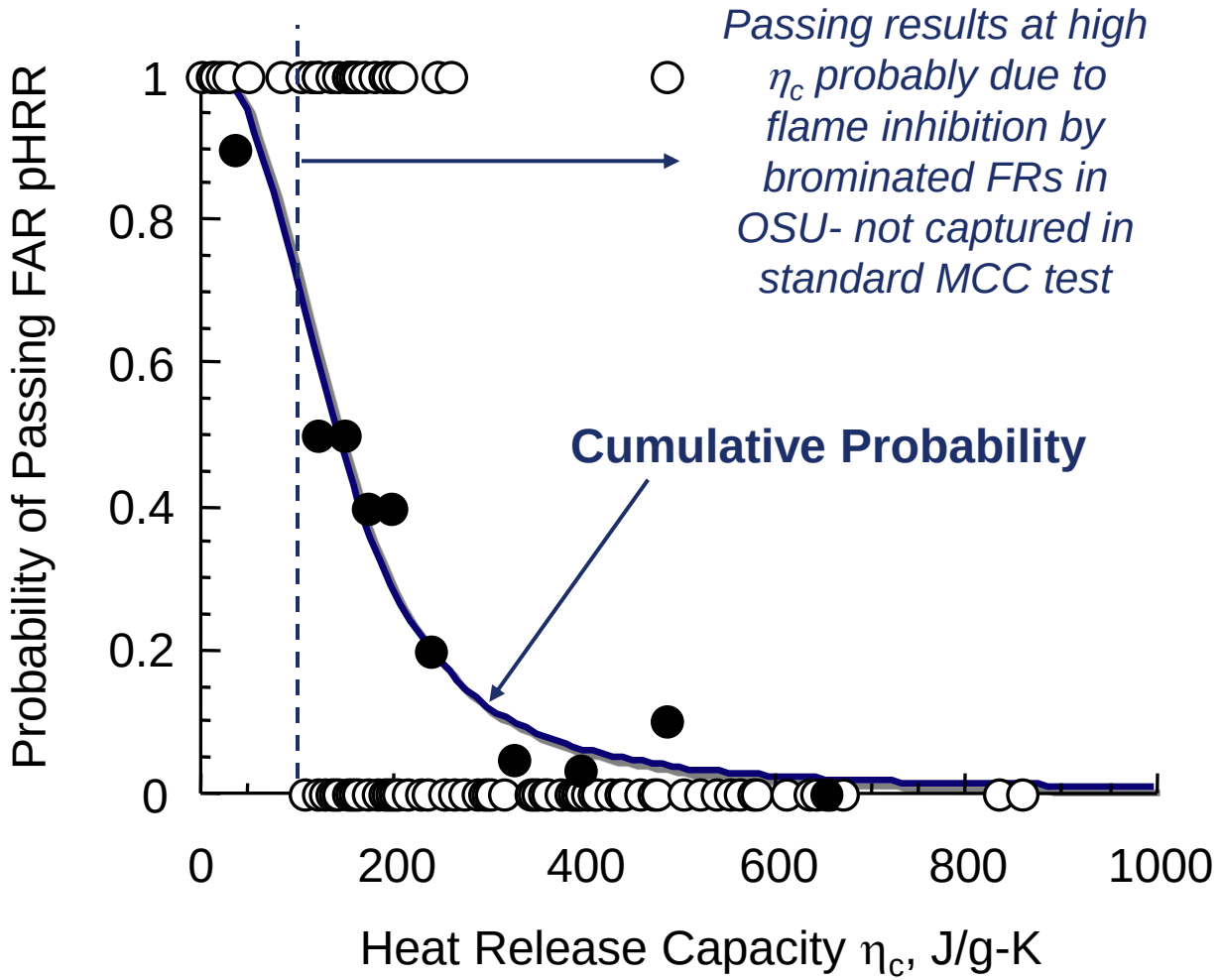
FLAMING COMBUSTION *NON-FLAMING COMBUSTION*

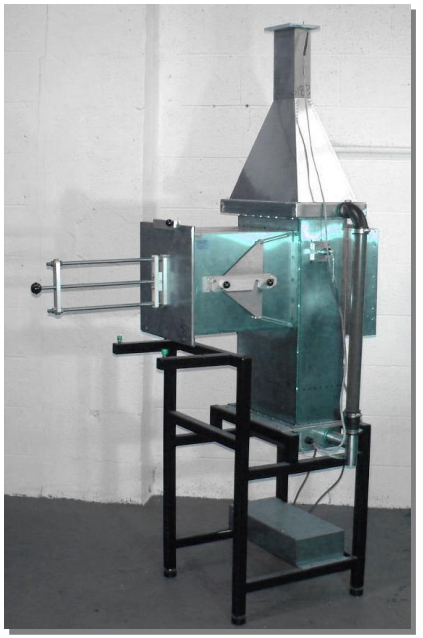
MCC Can Measure Flame Inhibition . . .



. . . but has not yet been correlated with pass/fail tests (VBB, OSU).

FAR 25 HRR and Heat Release Capacity

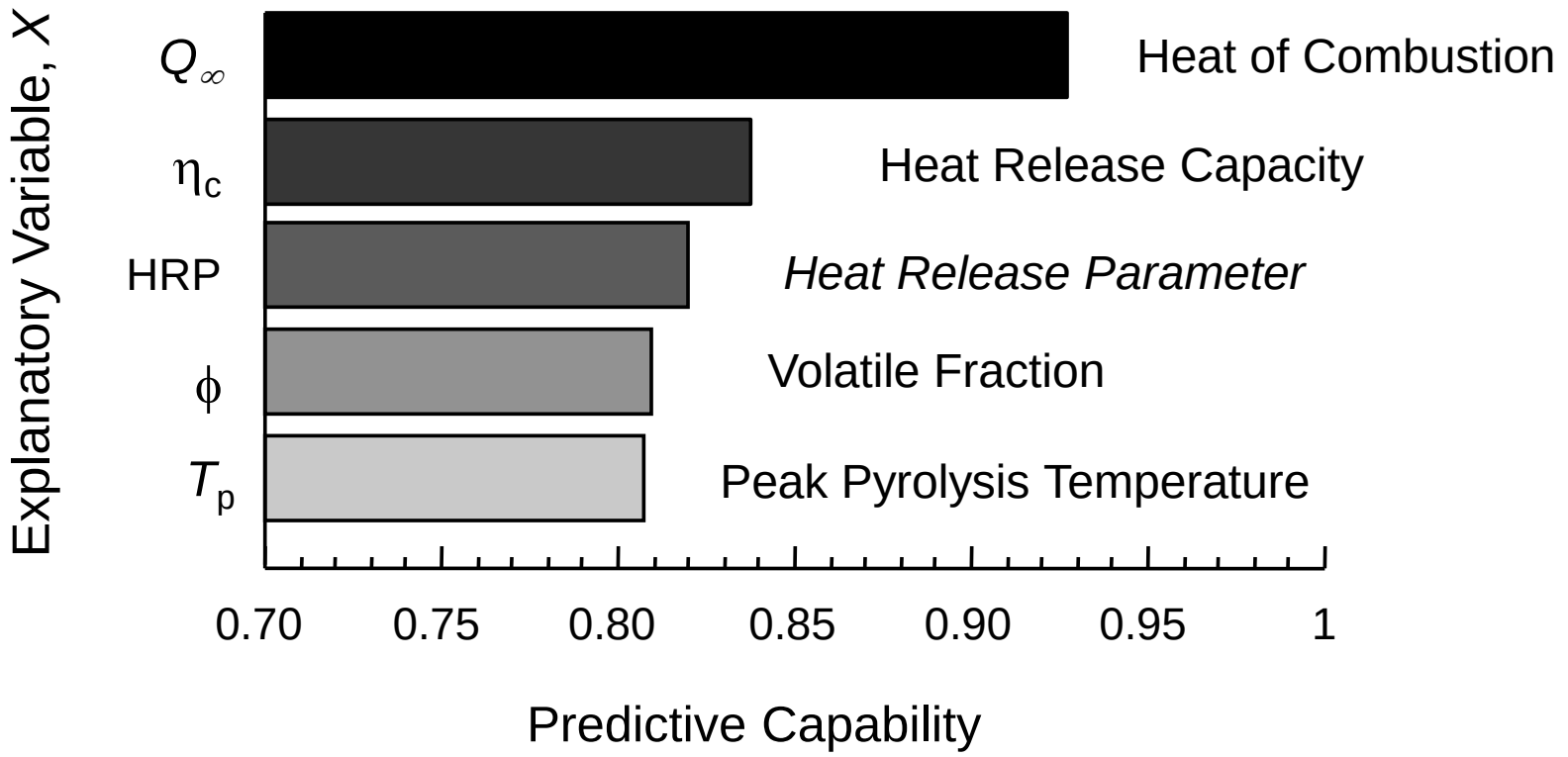




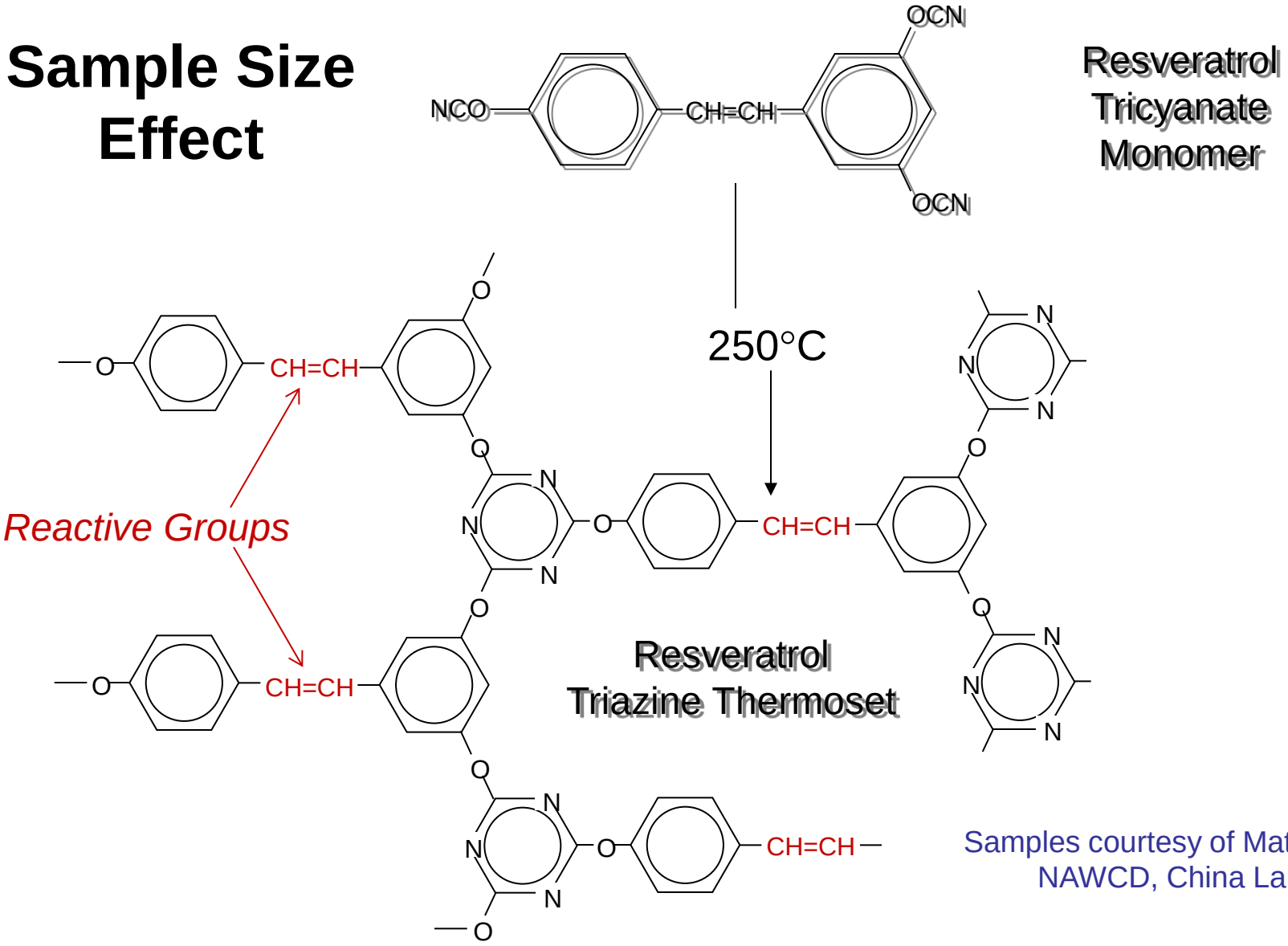
Binary Data

Bin Averages

Predictive Capability of ASTM D 7309 Material Properties in Pass / Fail Fire Tests

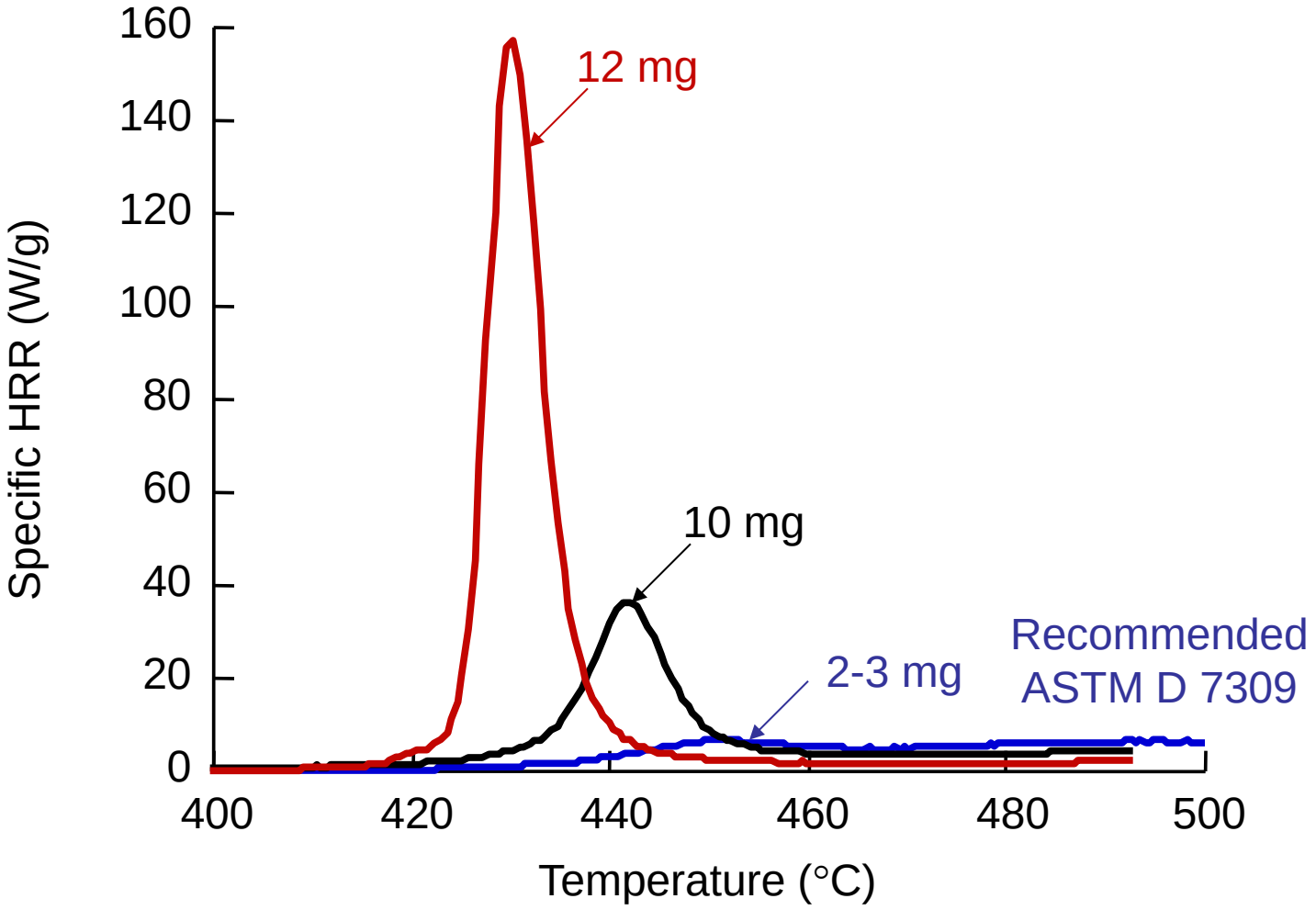


Sample Size Effect

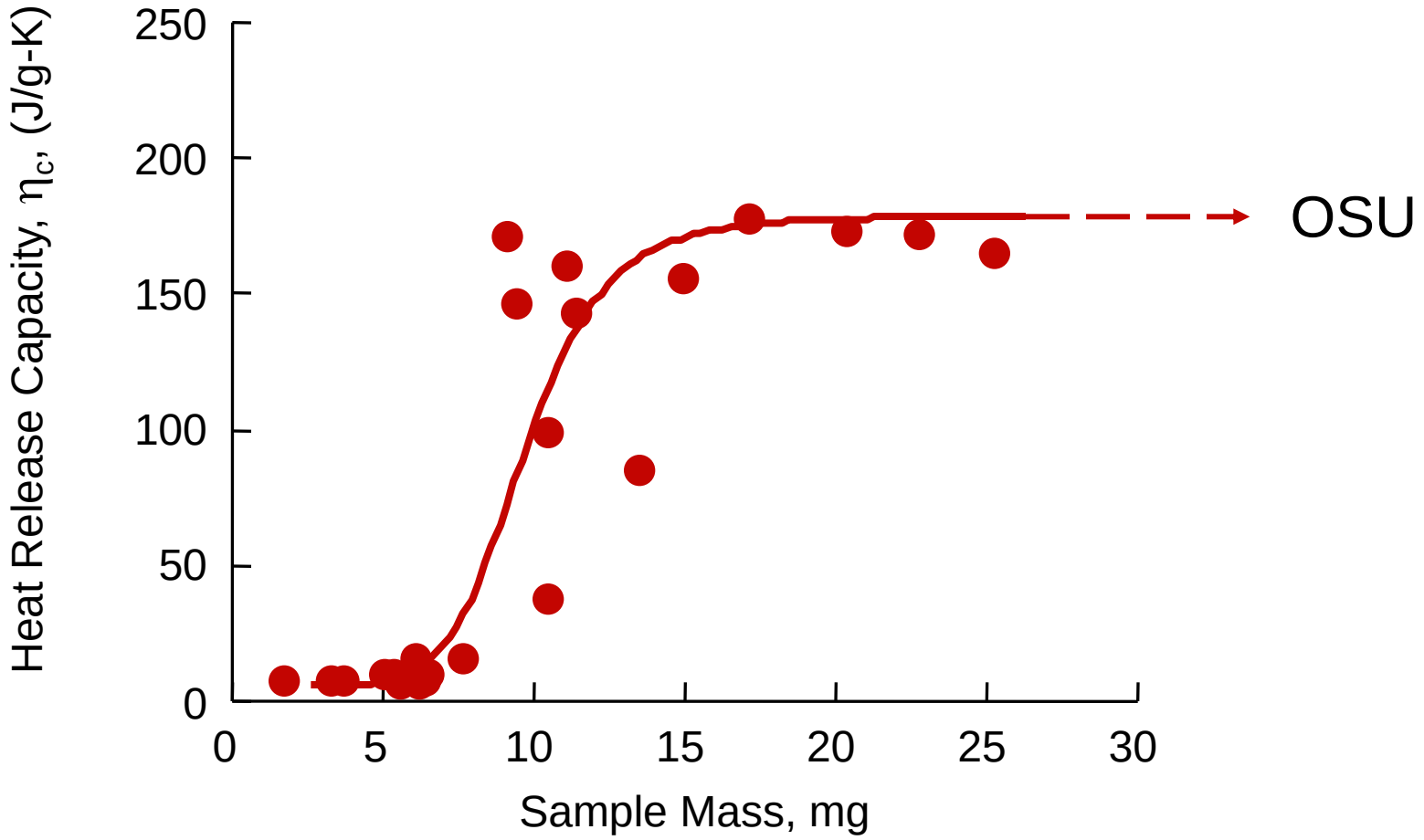


Samples courtesy of Matt Davis, NAWCD, China Lake

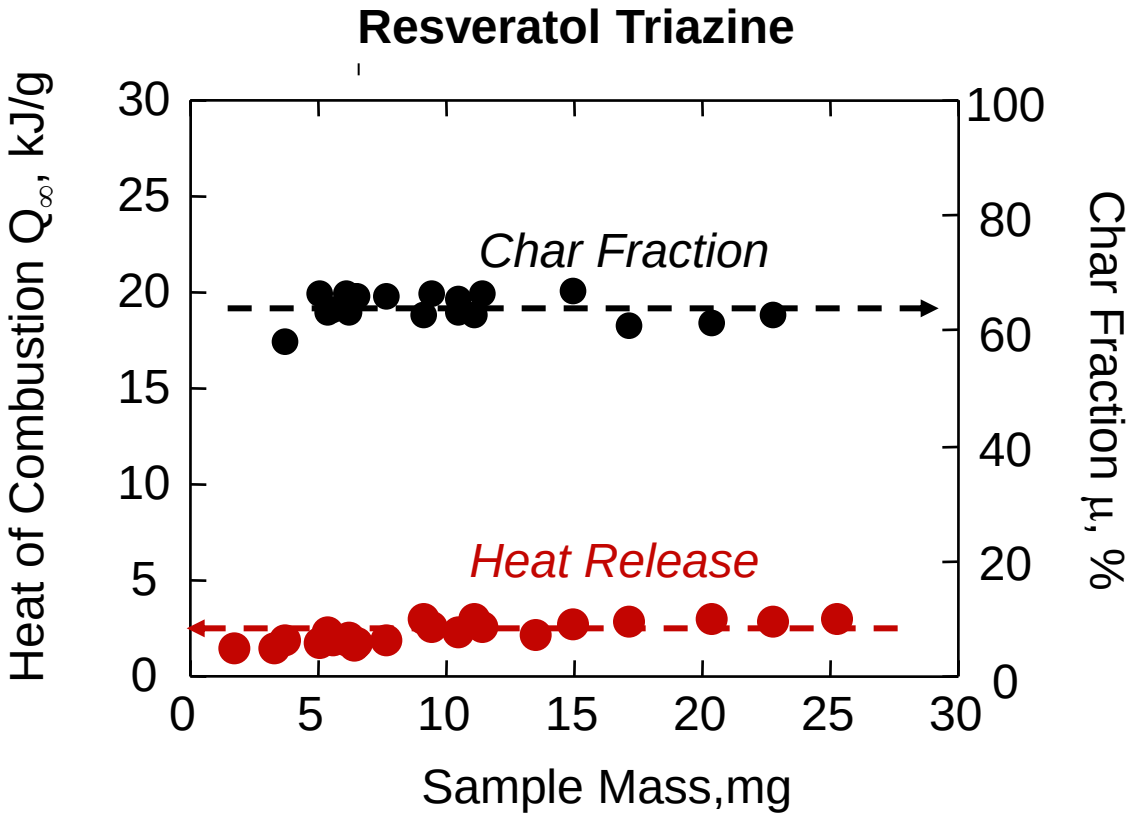
MCC Tests of Resveratrol Triazine



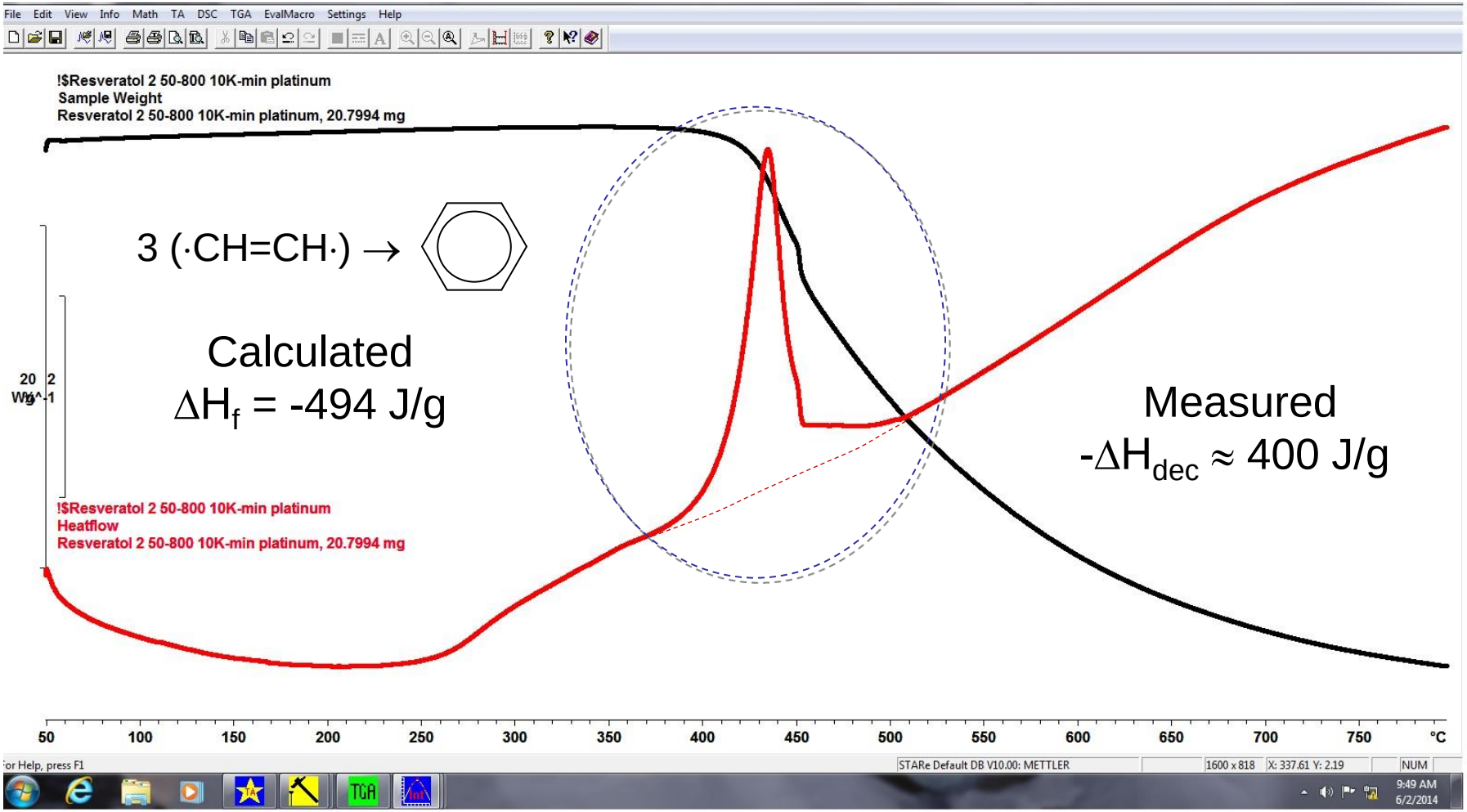
Effect of Sample Size on Heat Release Capacity of Resveratol in MCC



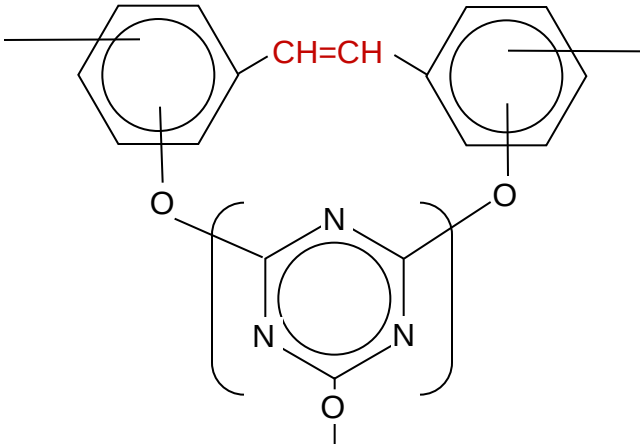
No change in decomposition chemistry associated with increase of η_c with sample size



DSC of Resveratrol Triazine Thermoset Shows Strong Exotherm

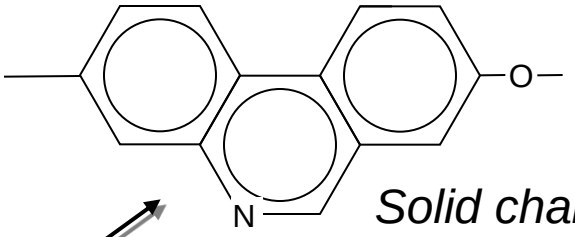


Combustion of Resveratrol Triazine in MCC



430°C

$\Delta H_d \approx$ -400 J/g
(exotherm)



Solid char
(67% of mass)

2 HOCN gas
(33% of mass)

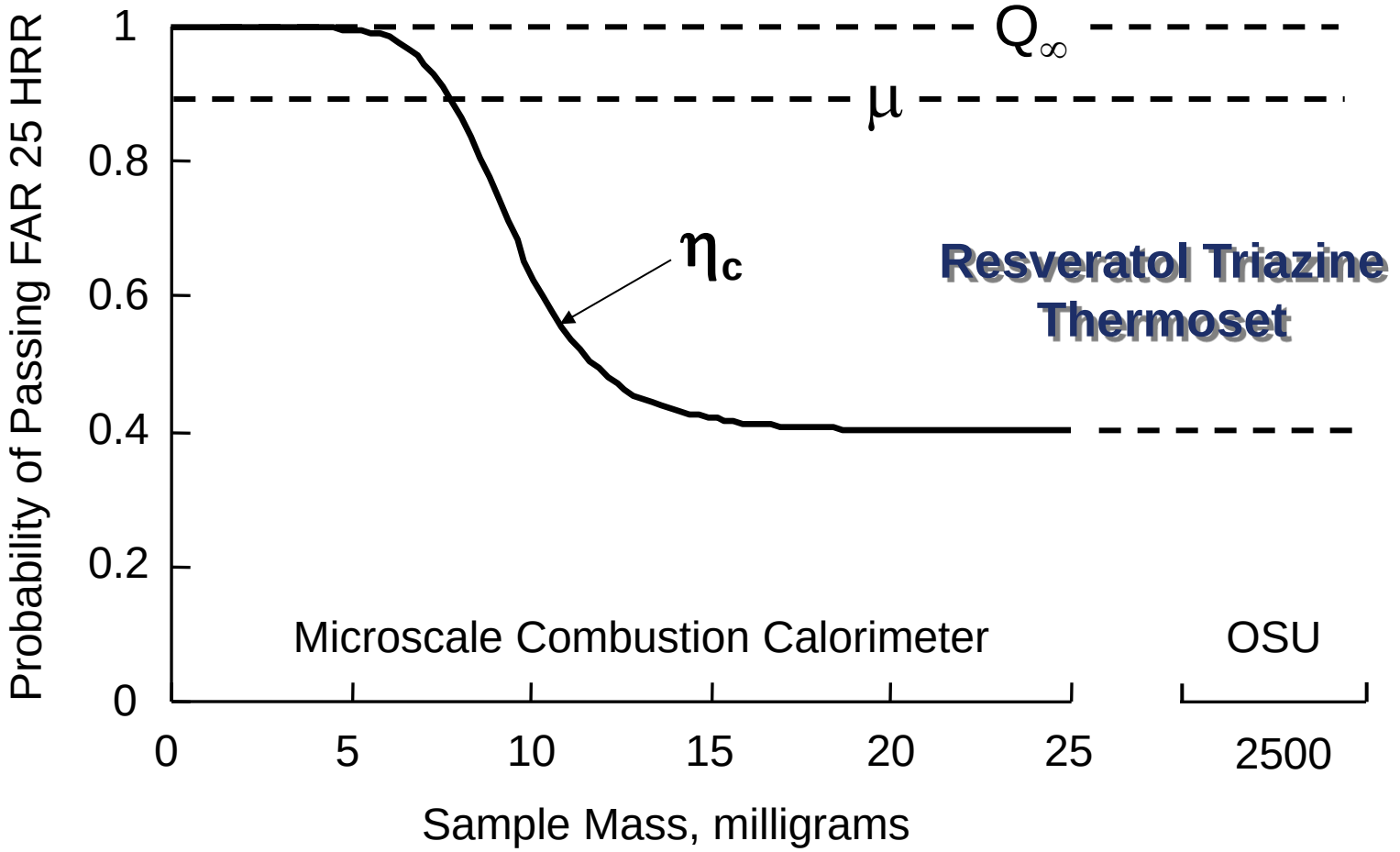
1000°C + *1.5* O_2

2 CO_2 + H_2O + N_2

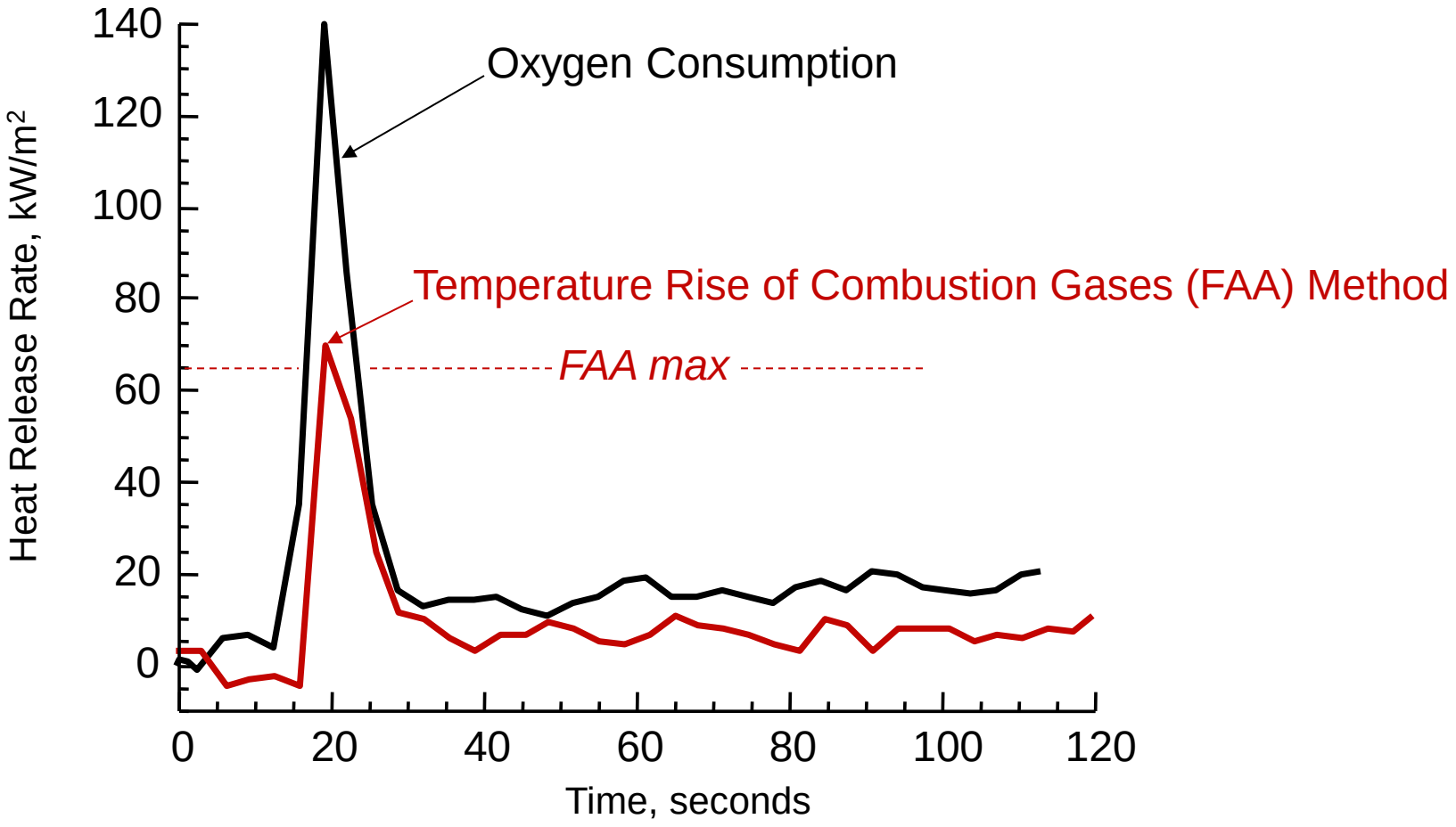
ΔH_c (ΔO_2, NIST) = 2.4 ±0.1 kJ/g-sample

ΔH_c (MCC) = 2.3 ±0.5 kJ/g-sample

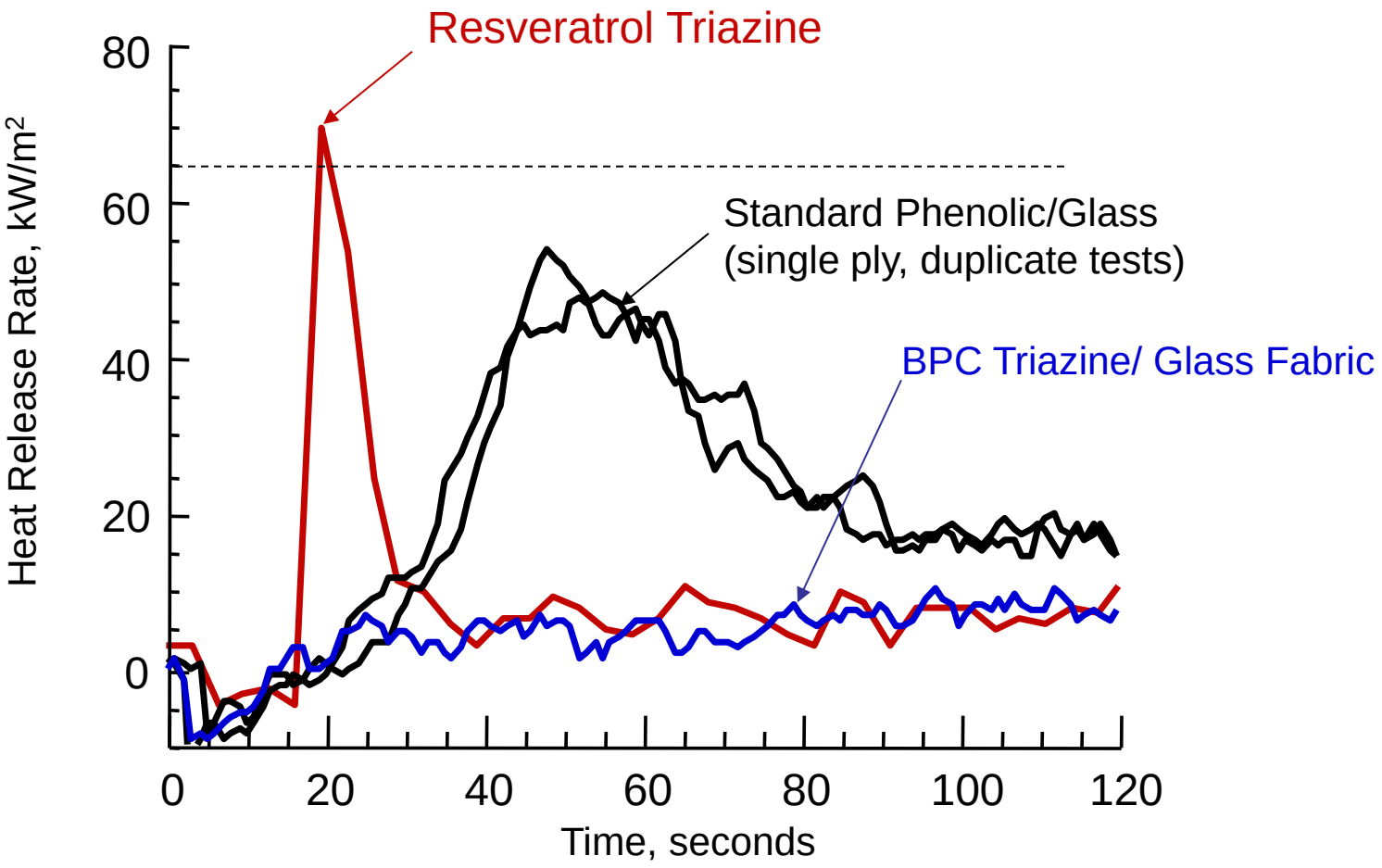
Probability of Passing FAR 25 HRR Versus Sample Mass



OSU Fire Calorimeter Testing of Resveratrol Triazine / Glass Fabric Lamina



OSU Fire Calorimeter Testing of Resin/Glass Fabric Lamina



Flame Retardants & Material Change Similarity Task Team

Goals of This Meeting:

- Appoint Industry Task Team Leader
- Assign FAA Liaison (Rich Lyon)
- Agree on Scope of Task
- Define Objectives
- Work Plan?