

## History of the Milligram-Scale Flame Calorimeter

Fernando Raffan- Montoya, Xi Ding, Jacques DeBeer, Stanislav I. Stoliarov  
UMD

R&D campaigns to develop novel flame retardant formulations can be costly, even at the bench scale. To address this issue, a novel apparatus was designed and tested: the Milligram-scale Flame Calorimeter (MFC). In the apparatus, a 30-50 mg sized sample is pyrolyzed and the volatiles are purged with inert gas. The flammable volatiles are ignited in a controlled atmosphere, establishing an axisymmetric, laminar diffusion flame. The apparatus can measure heat release rates via O<sub>2</sub> consumption calorimetry, along with direct gravimetric measurements of solid product (soot) yields and solid residue (char) yields. Over the years, modifications to the apparatus have added measurement capabilities such as CO and CO<sub>2</sub> yields, as well as an improved pyrolyzer design to better analyze intumescent samples. The history of the apparatus and its evolution will be presented along with key results from experimental campaigns dealing with sensitivity to gas-phase flame retardants, screening of synergistic additives, and benchmarking the MFC against well established test methods. The future expansion of the apparatus to include toxicity measurements will also be discussed, highlighting the potential for the MFC to be the first milligram-scale apparatus capable of flammability and toxicity measurements of solid fuels undergoing flaming combustion.