Capabilities of an innovative micropyrolyzer for studying chemical kinetics

**Goal**
- Determine the effect of heating time on yields of anhydrosugars from fast pyrolysis of biomass

**Background**
1. Biomass fast pyrolysis is typically considered finished in 0.5 – 5 s
   - Some evidence pyrolysis time is longer
2. When scaling up or designing a reactor, it’s important to know the optimal reaction parameters
   - To get these reaction parameters, kinetics and mechanisms are needed; however, they are difficult to determine
   - Kinetics and mechanisms would be easier to understand if we could “freeze” the reaction

**Apparatus and Methods**
**Controlled Pyrolysis Duration-Quench (CPD-Quench) apparatus**
- User sets pyrolysis time
- Sample (500 µg) is attached to dropper
- User begins run
- Automated:
  - Two minute purge time
  - Linear actuator lowers sample into pyrolyzer
  - Sample pyrolyzes for user-set duration
  - Sample is dropped into cold quench
  - Repeat until adequate products are formed
- Collect products and analyze (HPLC, GC/MS, etc.)

**Preliminary results**
- With the CPD-Quench at 500 °C with 5 minutes of pyrolysis time of 500 µg samples of cellulose yields 54.5 ± 1.5 wt. % levoglucosan
- With the same parameters except with 5 s of pyrolysis time, cellulose pyrolysis yields 51.6 ± 0.1 wt. % levoglucosan
- At 500 °C, py-GC-FID of 500 µg of cellulose yields 48.1 ± 2.1 wt. % levoglucosan

**Conclusions**
- Cellulose pyrolysis takes longer than previously expected
- More time points needed to determine pyrolysis duration
- Most likely highly temperature dependent
- CPD-Quench will help in determining mechanisms and kinetics for fast pyrolysis
- The CPD-Quench accurately “freezes” pyrolysis allowing innovative experiments to be run

**Appendix: Common Problems in Using Micropyrolyzers**
**Importance of Frequent Routine Maintenance**
- Micropyrolyzers make possible high throughput testing of samples, which should be accompanied by frequent maintenance to avoid pernicious loss of calibration

**Graphs**
- Cellulose pyrolysis volatiles over time as measured by FID
- Real time GC-FID
- Thousands

**References**