Effect of the vinyl group on the reactivity of lignin H, G, S units during biomass fast pyrolysis

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Background
Lignin structure

Coniferyl alcohol (Guaiacyl units)

$p$-coumaryl alcohol (Hydroxyphenyl units)

Sinapyl alcohol (Syringyl units)
Vinyl core structure

Experiments

- Phenolic acids as precursors to study 4-vinyl guaiacol pyrolysis chemistry
- Hypothesis: Vinyl group will impact reactivity by stabilizing the effect on the radical.
Micropyrolyzer set-up at LCT

TOF-MS

Micro-pyrolyzer

Customized Trace GC 1310

GC × GC
Micropyrolyzer set-up at LCT

- **Micro-pyrolyzer unit**
  - Two stage reactor
  - Large T-range: 40 - 900 °C
  - Multi-shot sample introduction
  - Cryo-trap for fast injection

- **Analytical section**
  - GC×GC - FID/TOF-MS: Simultaneous identification and quantification
  - Customized Trace GC 1310 with 3 Detectors
    - a. *TCD-1*: Water, formaldehyde
    - b. *TCD-2 & PDD*: Permanent gases up to C2
Preliminary Results

Gasification at low temperatures

- Gasification at 150°C
- Gasification at 300°C

Pyrolysis at high temperatures

- Even at high temperatures, the pyrolysis of ferulic acid mainly yields 4-vinyl guaiacol
- Additionally observed products could result from subsequent reactions of 4-vinyl guaiacol
- Planned gas phase studies will clarify this.

TOF-MS chromatogram for the pyrolysis of ferulic acid at 800°C

- Decomposition, not vaporization

Desired

\[
\text{(s)} \xrightarrow{\text{Decomposition}} \text{(g)}
\]

Observed

\[
\text{(s)} \xrightarrow{\text{Decomposition}} \text{(g)} + \text{CO}_2
\]
Future work

- Further investigate the vapourization/gasification of ferulic acid and other model compounds

- Study the influence of vinyl group on the reactivity as a function of temperature by comparing the other lignin model compounds phenol, guaiacol and syringol to their vinyl counterparts

- Investigate the influence of the presence of a methyl ester on reactivity

- Obtain complete experimental data sets to develop suitable kinetic models
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