

Modified lignin as biobased flame retardant

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Introduction

Flame retardants are components added to polymer formulations for fire safety. Commonly used flame retardants are halogen based which have a negative health and environmental impact. Stricter government regulations and impact concerns regarding flame retardants raise demands for safe alternatives.

Lignin

Lignin is a biopolymer found in plants. It's one of the most abundant sources of biomass available. Lignin is commonly obtained as a byproduct from papermaking industry or bio-ethanol refineries.

- Pros:
- Abundant
 - bio-aromatic
 - Repurposed byproduct
 - Rich in -OH groups
 - Some inherent flame retardant properties
- Cons:
- Heterogeneous structure
 - Difficult to dissolve
 - High molecular weight
 - Compatibility issues with polymers



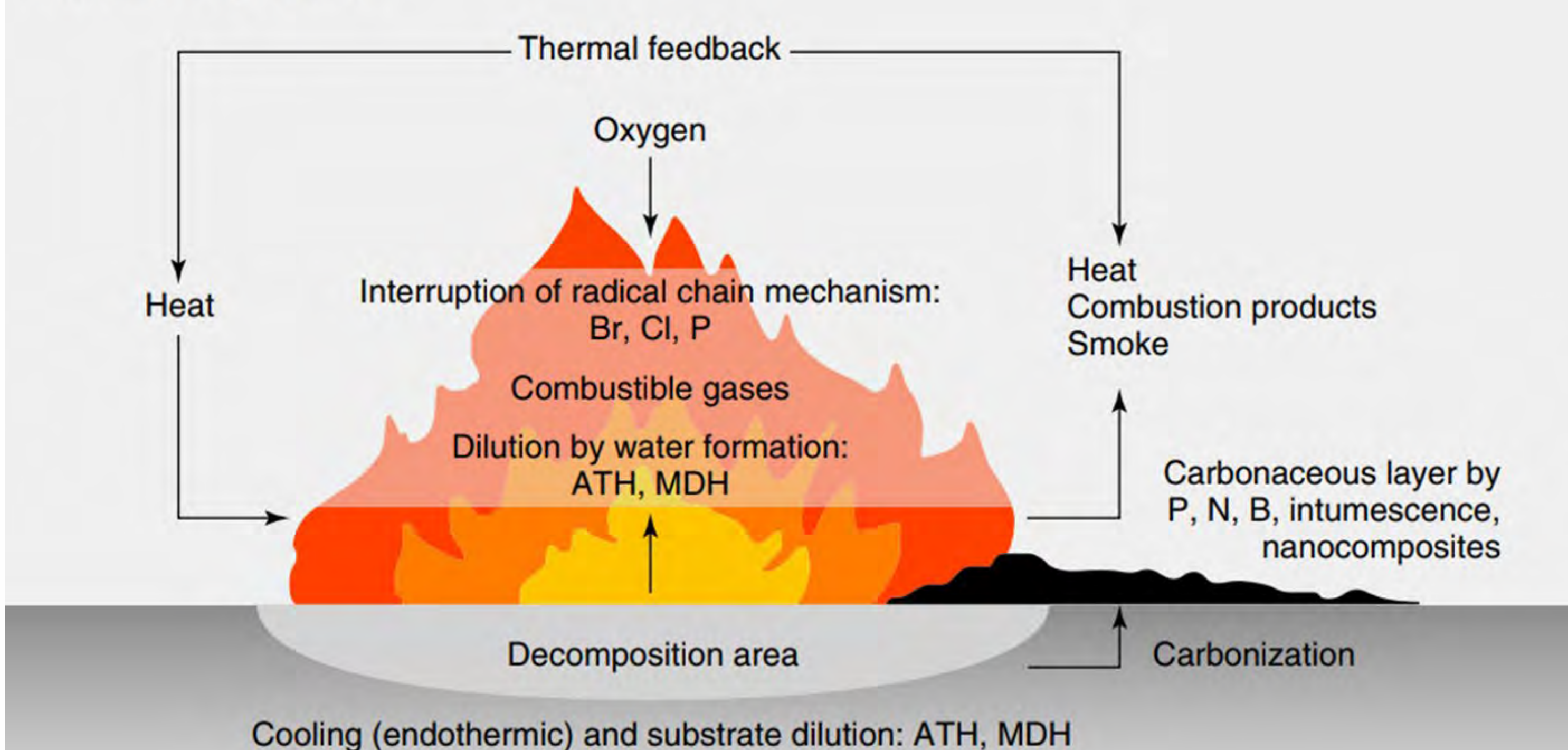
Flame retardancy

Flame retardancy

mechanisms:

- Cooling of the material
- Removal of oxygen
- Inhibition of free radicals
- Char formation

Action in the gasphase



Action in the condensed phase

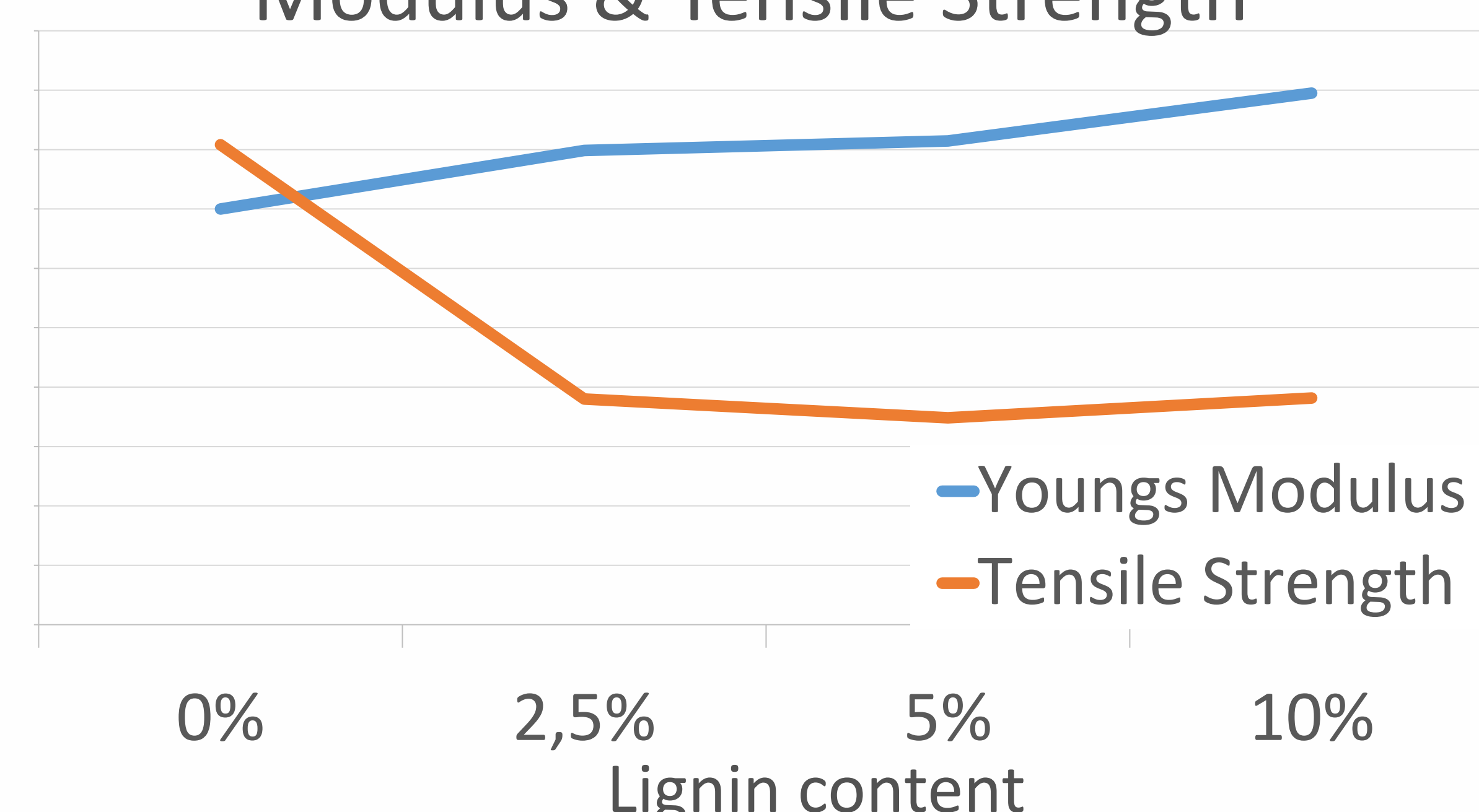
Figure: Process of fire and various ways mechanisms of flame retardants [3].

Approach

1. Modify lignin by attaching a phosphorus containing compound to lignin's -OH groups to aid flame retardancy
2. Incorporate (Modified-) lignin into polymer formulations + Characterization
3. Add additional components to formulation to improve properties

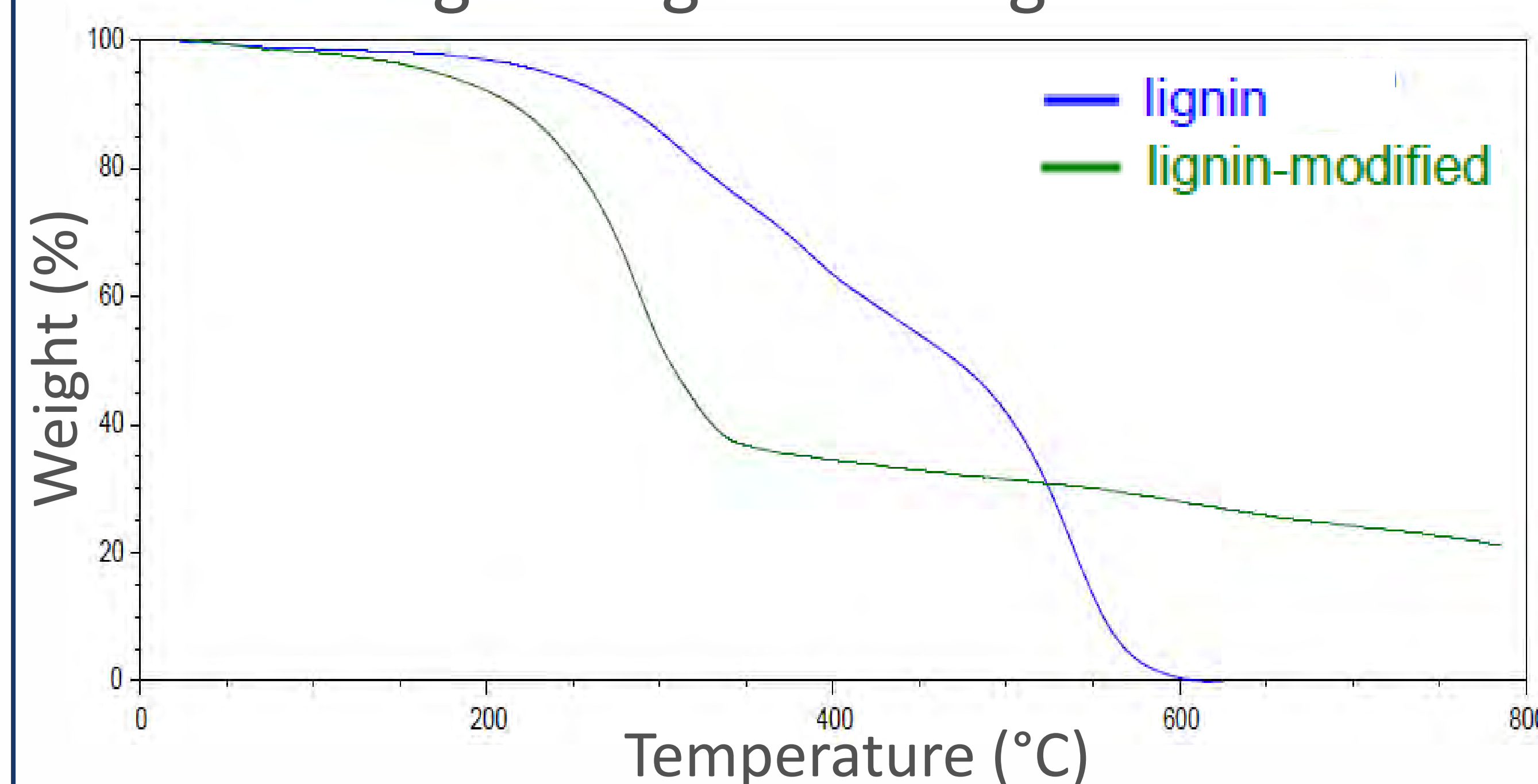
Results

Influence Lignin content on Young's Modulus & Tensile Strength



- Slight increase in Young's Modulus with lignin content.
- Sharp initial decline of Tensile Strength with lignin content but levels at higher contents.

Thermogram lignin and lignin modified



- Modified lignin less thermally stable but produces char

Challenges and Future

- Workability difficulties processing with modified lignin
- Unknown toxicity profile of modified lignin
- Perform industry standard flame test: UL-94

References

1. G. P. Mendis et al., "Phosphorylated lignin as a halogen-free flame retardant additive for epoxy composites," Green Materials, vol. 4, no. 4, pp. 150-159, 2016.
2. G. Audisio et al., "Flame retardants for polypropylene based on lignin," Polymer Degradation and Stability, vol. 79, no. 1, pp. 139-145, 2003.
3. Ullmann's Encyclopedia of Industrial Chemistry