



Plastics from Pine Sap: Insight into the Ring-Opening Metathesis Polymerization Thermodynamics of Monoterpenes



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Background

- **Ring-Opening Metathesis Polymerization (ROMP)** is a polymerization reaction of cyclic olefins with high steric & thermodynamic control.
- **α -pinene** is a monoterpene that cannot undergo ROMP.
- **δ -pinene¹** is a novel isomer of α -pinene with an accessible olefin, capable of undergoing ROMP.

Motivations

- Evaluate the potential for biomass-based chemical feedstocks to replace petrochemicals in plastics.
- Further understanding of ROMP and its steric and thermodynamic requirements.

Monomer Synthesis

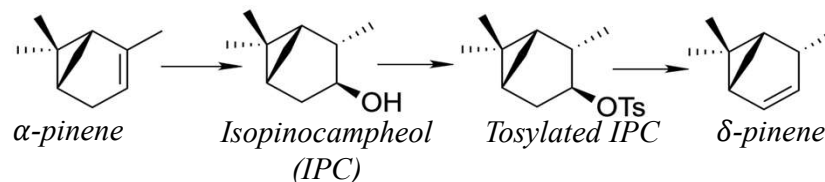
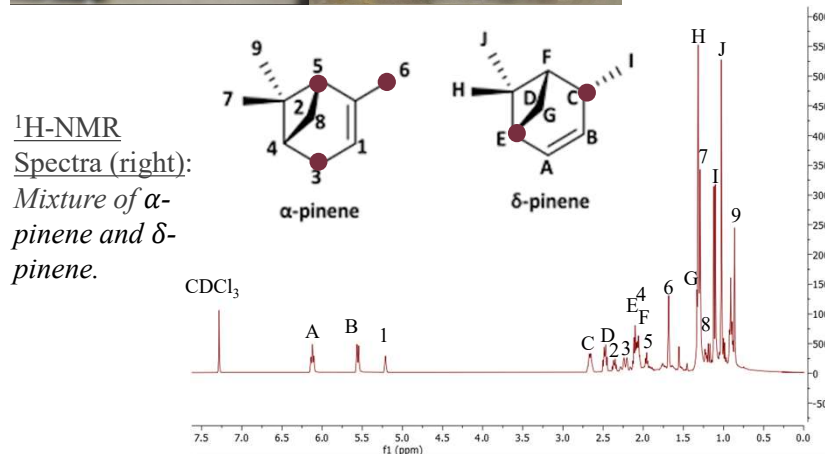


Image descriptions:
 Crystallized IPC (left);
 Tosylated IPC after 48 hours of reacting (right).



Findings

- Via ROMP:
- **Poly- δ -pinene properties:**
 - Monomer RSE: 35.1 kJ/mol
 - T_g (DSC): 87–101°C
 - \bar{D} (SEC): 1.06–1.35
 - M_n (SEC): 4–75 kDa
 - Conversion: 83–99%

Prospects:
 (Co)polymerization (w/ CP, Lactam, etc) and mechanical testing.

References

¹“Ring-Opening Metathesis Polymerization of δ -Pinene: Well-Defined Polyolefins from Pine Sap.” Yarolimek, M.R. et al; *ACS Macro Letters* **2021** 10, 760-766