

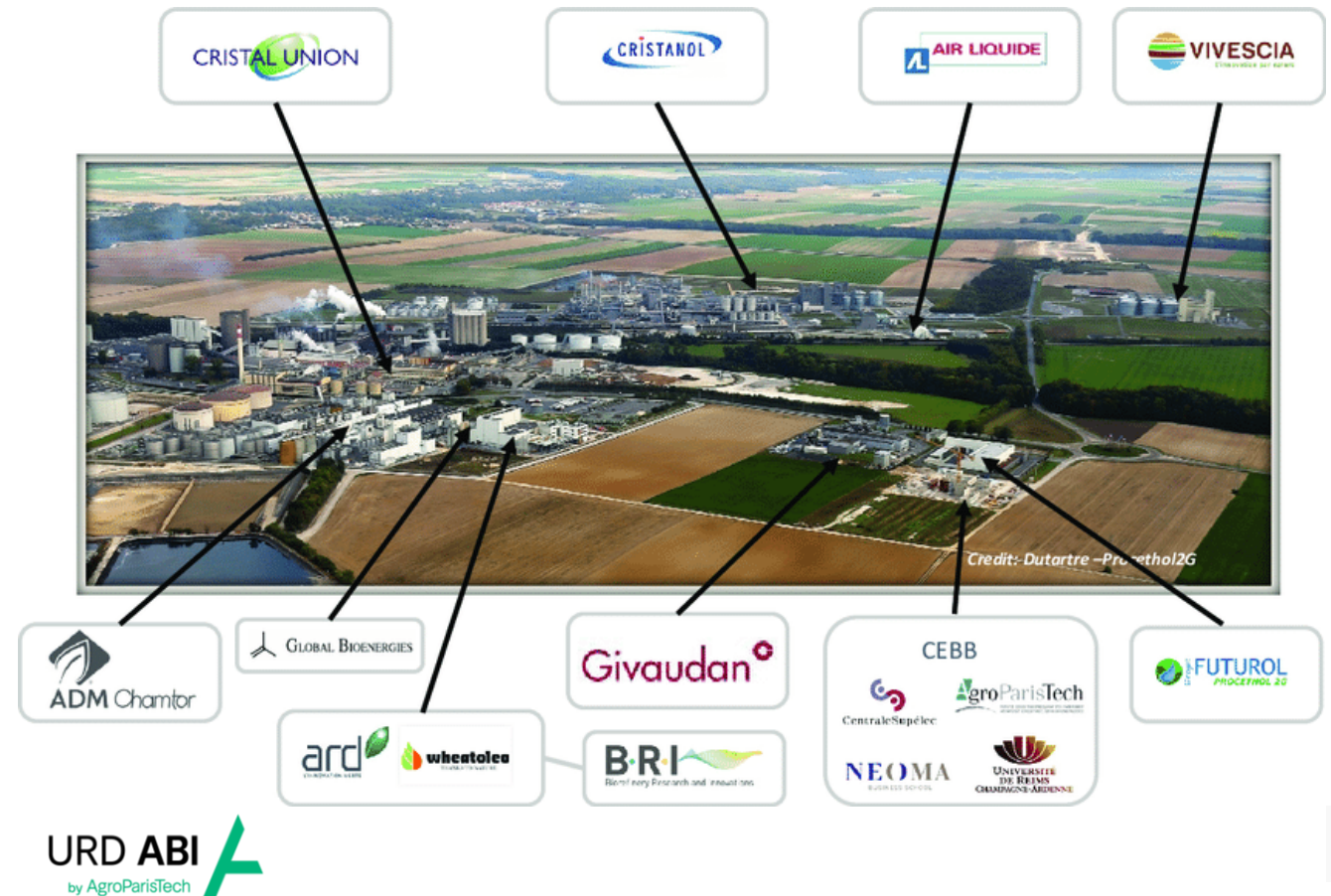
Synthesis and characterization of novel levoglucosenone polymers

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Internship Organization

- » Research Institution: URD ABI (Industrial Agro-Biotechnologies R&D Unit) by AgroParisTech (part of Paris-Saclay University)
- » Location: Reims, France – the largest city of the Champagne region
- » Part of Europe's largest biorefinery complex: Bazancourt-Pomacle
- » Supervisor and mentor: Sami Fadlallah
- » Graduate student: Enzo Petracco
- » Lab director: Florent Allais
- » iREU conducted through the University of Florida



Experiences

Visits to:

- » Givaudan Active Beauty (manufactures active ingredients for cosmetics using biotech)
- » Cristal Union (manufactures ethanol and CO₂ from wheat)



Background on Polymers

» Polymer classifications:

- Cross-linked vs. network
- Thermoplastic vs. thermosetting
- Amorphous vs. crystalline regions

» Amorphous materials – glass transition

- Change from *glassy* to *rubbery* when heated; at a lower temperature than fusion

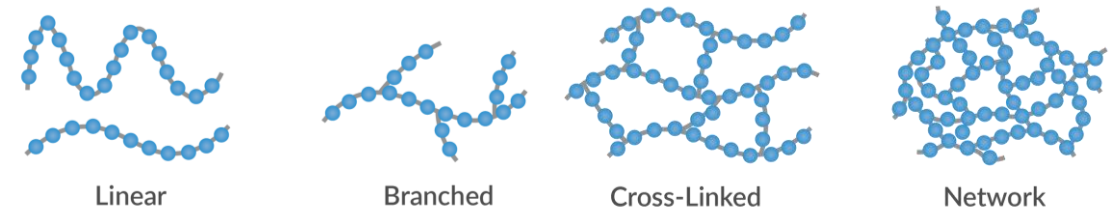


Fig. 1 – Polymer structures



Fig. 2 – Semicrystalline polymer

[1] Tahara et al., 2025, *Polymer Science*

Background – Polymer Analysis

- » Differential scanning calorimetry (DSC)
 - Sample is subjected to a heat/cool cycle, its heat flow is measured relative to a reference – useful to identify the glass transition temperature
- » Thermogravimetric analysis (TGA)
 - Sample is heated, its mass is recorded – reveals the thermal stability of the polymer

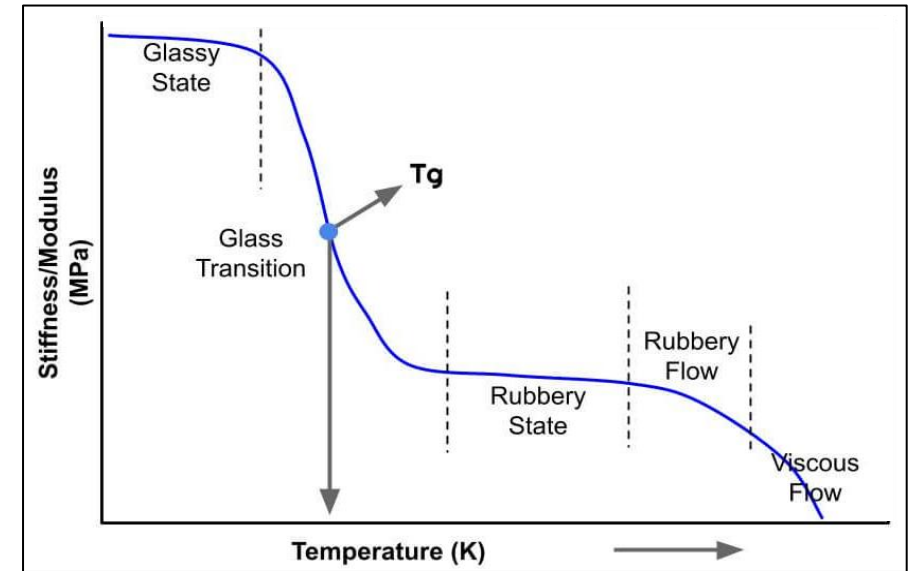


Fig. 3 – Glass transition, *Corrosionpedia*



Fig. 2 – DSC and TGA machines, *TA Instruments*

[1] Tahara et al., 2025, *Polymer Science*

Background on Levoglucosenone (LGO)

- » Commercially available biobased feedstock
 - Produced from the pyrolysis of cellulose
- » Properties:
 - Rigid skeleton enables reactions with high regio- and stereoselectivity
 - Conjugation grants susceptibility to Michael-type reactions
 - 1,2-condensation leads to imine products
- » *Platform molecule* – extensively investigated for polymer synthesis

[2] Camp and Greatrex, 2022, *Frontiers in Chemistry*

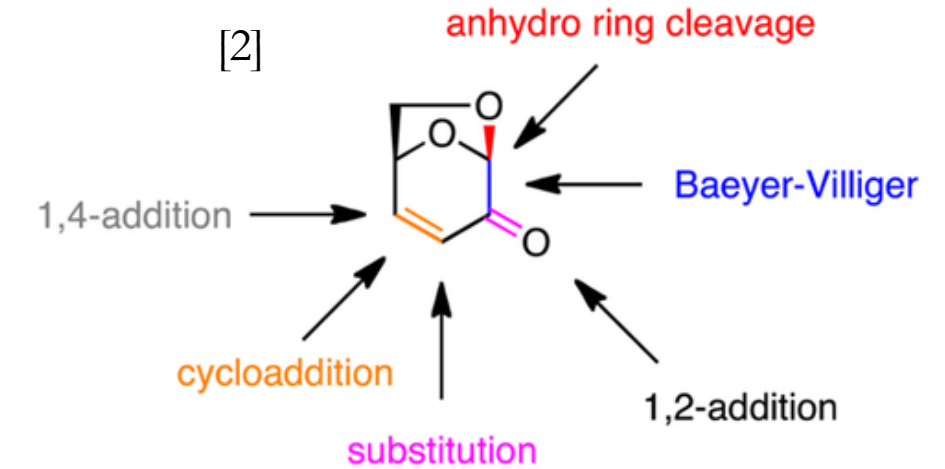


Fig. 3 – LGO Reactivity

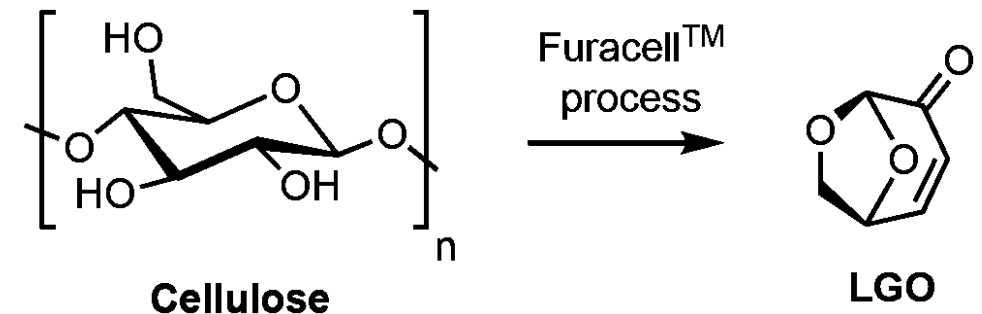


Fig. 4 – Production of LGO from cellulose

Project Overview

- » LGO-derived monomers have been used to create varied polymers
 - Many developed here at ABI
- » This work reports the development of novel materials using LGO as the co-monomer
 - Potentially reduced costs and a lower environmental impact compared to existing methodologies
- » These materials were characterized using a variety of analytical techniques including DSC, TGA, NMR and FTIR spectroscopy, and gel-permeation chromatography (GPC)

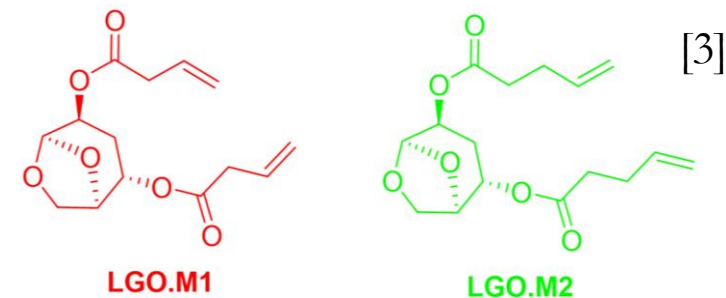


Fig. 3 – LGO-derived monomers

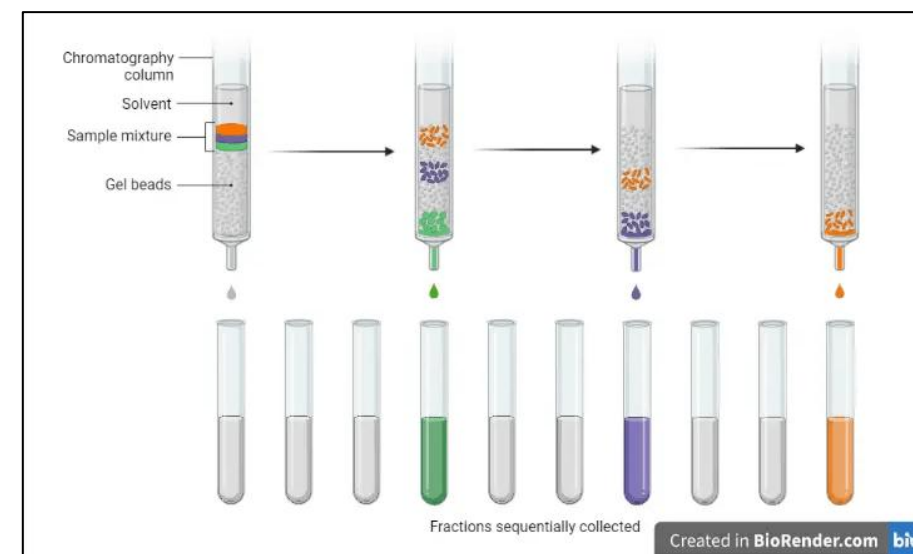


Fig. 4 – GPC fundamental concepts

Results and Discussion

- » Synthesis proceeded with LGO as the co-monomer, with a facile polymerization observed under mild and sustainable conditions.
- » DSC and TGA analysis revealed varied glass transition temperatures and thermal stabilities for the materials synthesized.
- » These findings demonstrate that LGO can serve as a cost-effective, sustainable monomer platform, broadening the design space for renewable polymers

Fig. 5 – ^1H -NMR

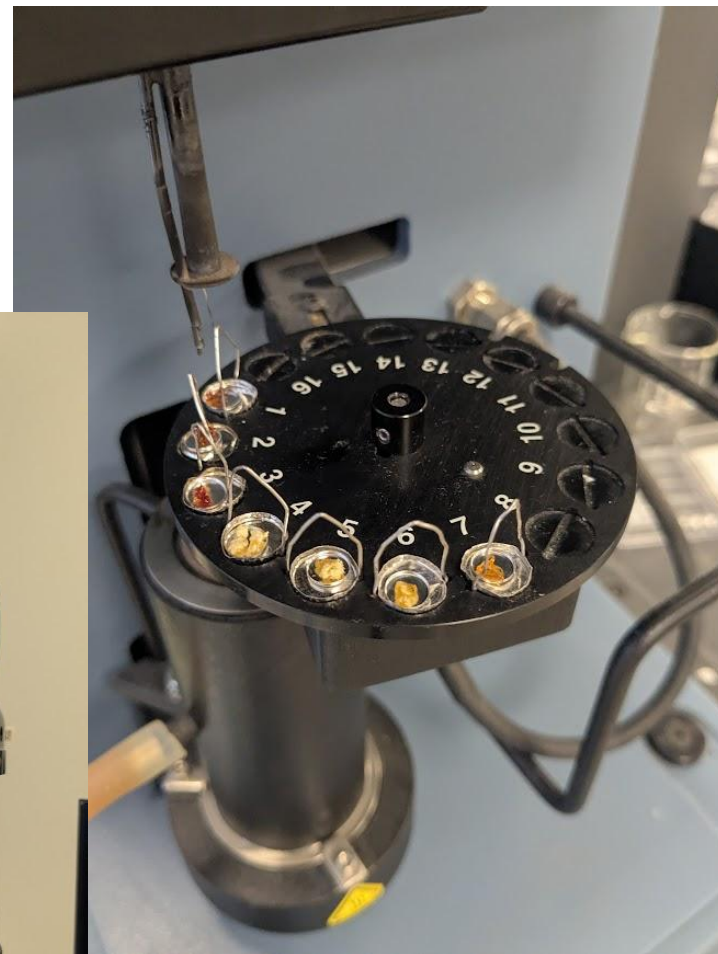
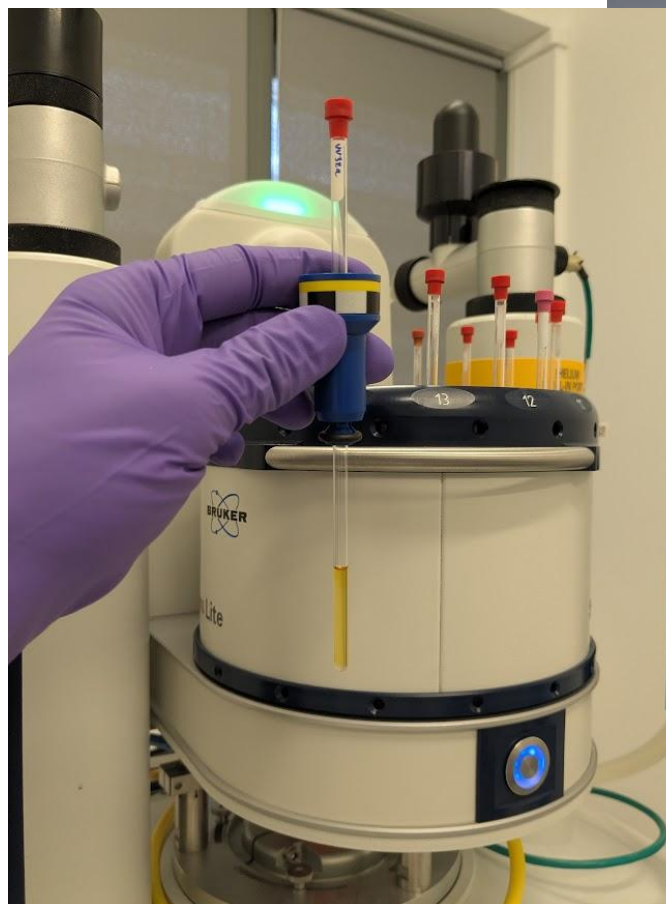


Fig. 6 – TGA
(various samples)

Takeaways

What I knew:

- » Theory behind IR spectroscopy and carbon and proton NMR
- » Size-exclusion chromatography for protein purification
- » Organic chemistry basics including addition reactions to enones

What I've learned:

- » TGA
- » DSC
- » GPC
- » Crystalline/amorphous materials and glass transition
- » Swelling and solubility calculations
- » Practice of FTIR and NMR

Looking Forward

Professional Preparation

- » Improved lab competency
- » Improved project management
- » Improved professional communication
- » Improved science communication
 - Grant writing
 - Popularizing science
 - Garnering community support
 - Science outreach and education

Next Steps

- » American Chemical Society Conference in March 2026





URD ABI 
by AgroParisTech

Thank you

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