From Beet Pulp To Building Blocks and Polymers Developing Value Added Materials From GalX

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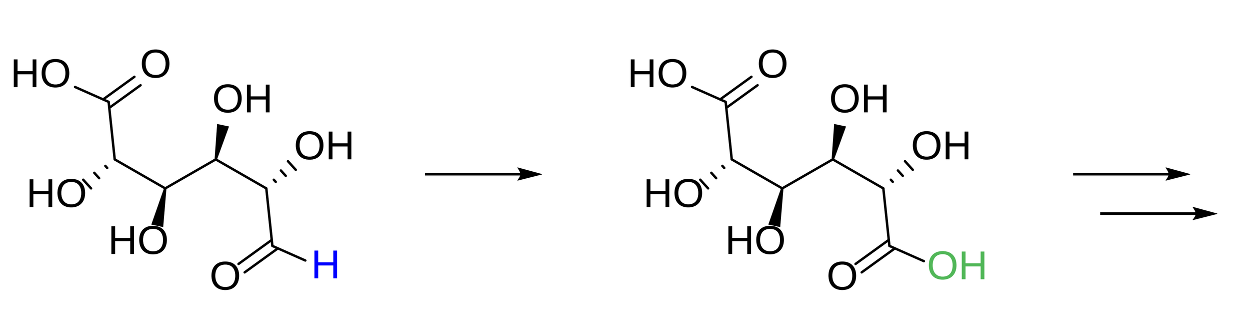
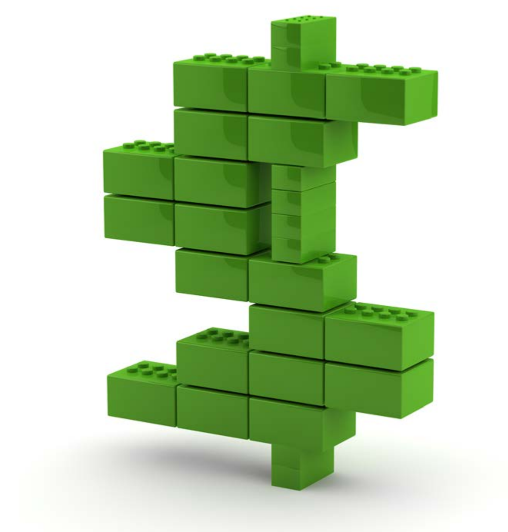
The increasing demand for 2nd generation bio-based performance materials presents an excellent opportunity for the development of agricultural residues like sugar beet pulp (SBP) as feedstock for renewable polymers. Refining SBP yields various industrially interesting components, such as galacturonic acid. This sugar acid can be transformed into a novel family of bio-based building blocks called GalX. Here we report on the use of GalX building blocks in bio-based polymers.





Introduction

As the transition from a fossil-based to a bio-based economy is beginning to take shape, the demand for renewable performance materials is increasing. The use of non-food bio-based feedstocks is a prerequisite for producing 2nd generation bio-based materials. Ideally, agricultural residues such as straw, bagasse, or sugar beet pulp (SBP) are used. SBP contains several industrially interesting components, including e.g. cellulose, pectin, arabinose and galacturonic acid. Catalytic oxidation of this uronic acid, efficiently yields galactaric acid.[1] This can e.g. be converted into 2,5-furandicarboxylic acid (FDCA), a widely advocated bio-based alternative for terephthalic acid, used in polyesters like PET.[2] Alternatively, galactaric acid can be converted into a family of building blocks called GalX, which were shown to have interesting properties when incorporated into conventional polyesters.[3] Here we report on the use of GalX building blocks in bio-based polymers.

From pulp to GalX

SBP refining yields, amongst others, galacturonic acid. Subsequent catalytic oxidation yields galactaric acid in high yield and high selectivity. Esterification, acetalisation, and optionally reduction, finally give the GalX building blocks.

GalX (co)polyesters

- Copolyesters based on FDCA, GalX and ethylene glycol could be used for triggered (bio)degradation.
- Small amounts of GalX (<10%) do not significantly influence material properties.

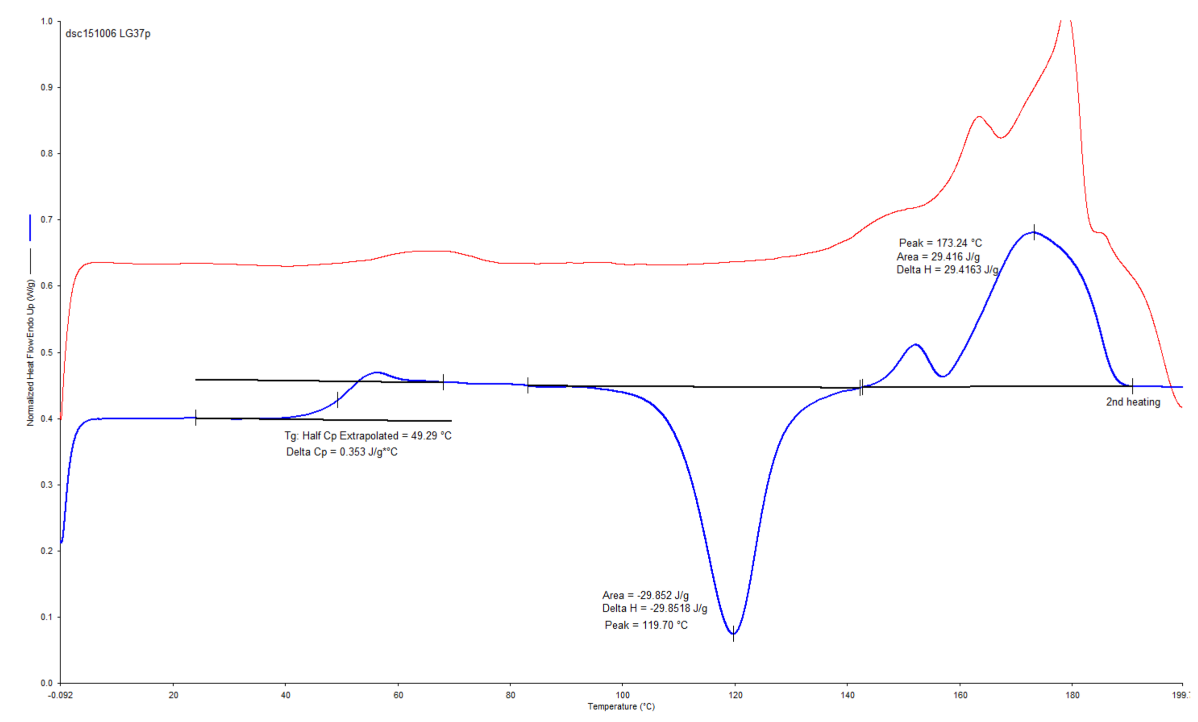
polymer	M_n	M_w	M_w/M_n	T_g	T_m
PEF100	6,300	11,300	1.8	78	200
PEF98	12,300	29,200	2.4	62	206
PEF95	7,700	13,100	1.7	58	198

Crude PEF95

Purified PEF95

GalX polycarbonates

- Novel polycarbonates successfully prepared and characterised.
- High MW's, up to 38,000 D
- Thermally stable up to 300 °C
- Excellent thermal properties
- Semi crystalline materials



- Low colour
- Potentially biodegradable

Conclusions

- Incorporation of GalX into polyesters yields materials with interesting properties.
- Polycarbonates based on GalX platform have industrially relevant properties.

References

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3. S. Muñoz-Guerra, C. Lavilla, C. Japu and A. Martínez de Ilarduyaa, *Green Chem.*, 2014, 16, 1716-1739.

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