Intensified Continuous Flow Process for the Scalable Production of Bio-based Glycerol carbonate

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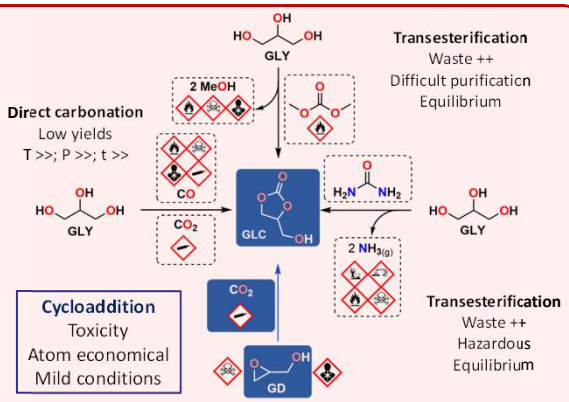
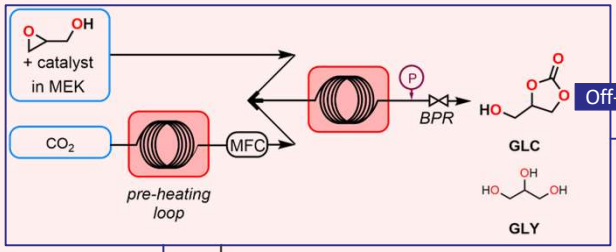
Context

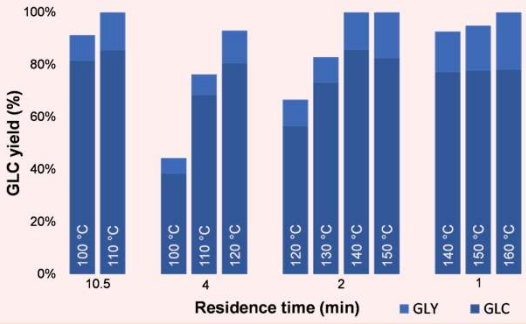
- The current escalation of greenhouse gas emissions is now undeniably identified as one of the main drivers for precipitating climate change
- CO_2 stands theoretically as an ideal feedstock at our disposal, because of its wide availability and low cost
- Among reachable linear and cyclic carbonates involving CO_2 as reagent, glycerol carbonate (**GLC**) is a very appealing building block with a plethora of applications comprising battery electrolytes, monomers and green solvent to name a few
- Current industrial processes toward **GLC** display a very poor atom economy and a global low process efficiency
- Over the last years, research efforts were mainly focused on the carbonation of epoxides and especially, the engineering of solutions to overcome the thermodynamic barrier of CO_2

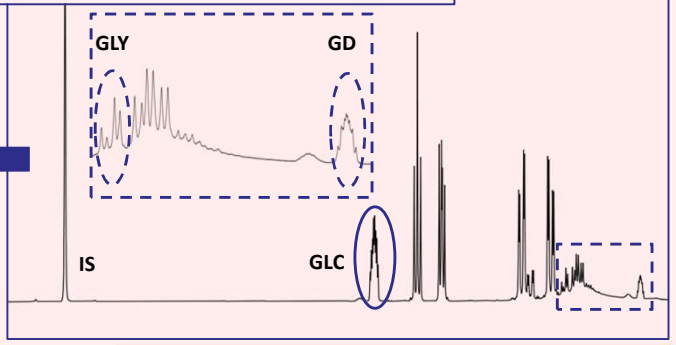


Results

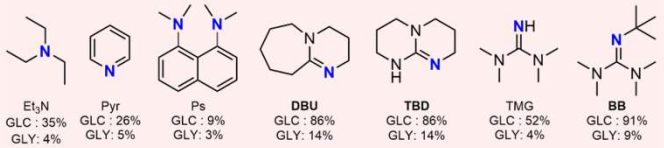
- Preliminary optimization highlighted the promotion of **GLC** and **GLY** formations with increasing temperature
- Determination of 1 equiv. of **CO_2** as the most adequate flow rate to enhance **GD** conversion alongside with 10 bar of counter pressure
- 1,5,7-Triazabiscyclo[4,4,0]dec-5-ene as model catalyst



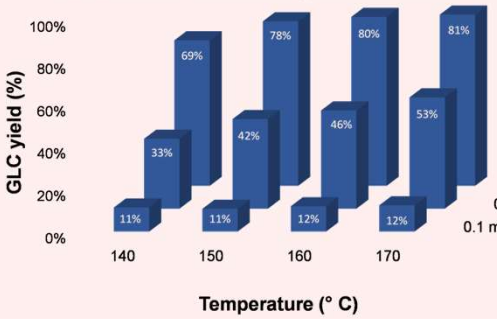




- Catalyst screening at 5 mol% in respect to **GD** (2 min, 140 °C, 10 bar)



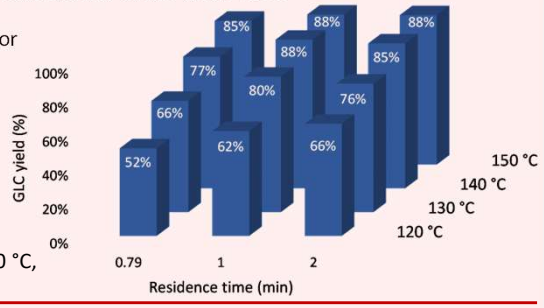
- All catalysts screened showed an unneglectable activity
- DBU and TBD displayed 86% of **GLC** yield
- Barton's base achieved highest conversion and selectivity toward **GLC**



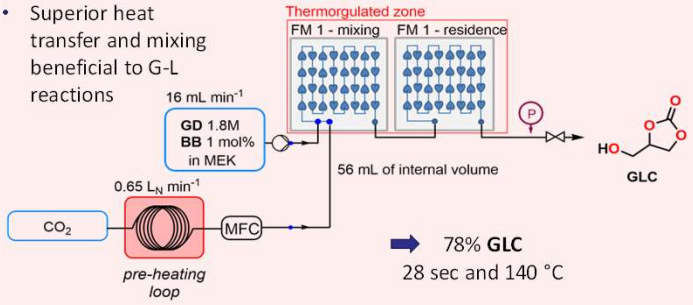
- **GLY** formation between 1 and 10%

- Scale-up of **GD** carbonation with 1 mol% of BB
- Low flow reactor (13,5 mL)
- Clogging issue at 150 °C, 2 min

➡ 85% **GLC**
0,79 min and 150 °C,



- Superior heat transfer and mixing beneficial to G-L reactions



➡ 78% **GLC**
28 sec and 140 °C

Conclusion

- Development of a continuous flow process for the efficient and fast production of high added-value **GLC** with minor formation of **GLY**
- Identification of Barton's base as innovative and highly selective organocatalyst for **GD** carbonation at low catalyst loading
- Successful transposition to pilot reactor using an Corning® Advanced-Flow™ G1 reactor offering an greener alternative to current industrial processes

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Metrics

- Production output : 3,6 kg day^{-1}
- Space time yield : 2,7 kg h^{-1}L^{-1}
- E-factor : 1,99

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