



Polymers  
from CO<sub>2</sub>

# CO<sub>2</sub> Use in Plastic Materials

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13th Annual APGTF Workshop

# Carbon Capture with Compelling Economics

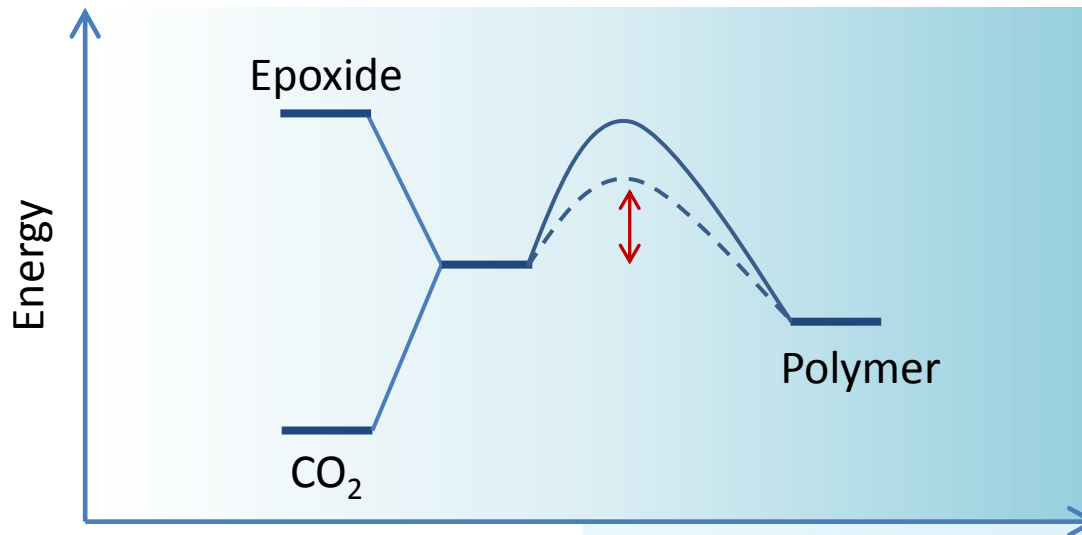
- SME from Imperial College London Chemistry Department
- Proprietary catalyst technology
- Enables use of CO<sub>2</sub> to form polymers
- Displaces up to 50% of conventional, petrochemical feedstock with CO<sub>2</sub>
- Cost of traditional feedstocks: ~\$2,000/t
- Cost of CO<sub>2</sub>: free (\$50/t to capture and process)



# CO<sub>2</sub> as a Feedstock for Polymers

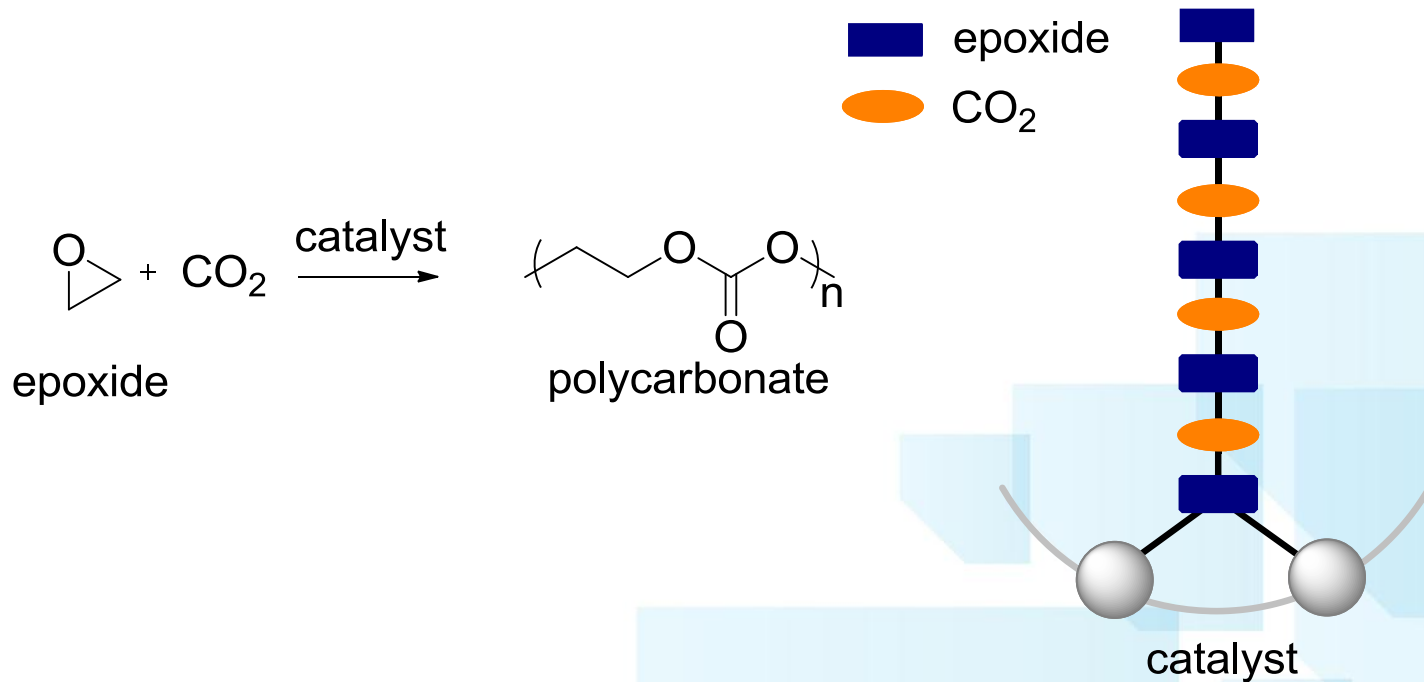
- CO<sub>2</sub> is cheap but unreactive
- Energy required for transformation
- Energy barrier to polymer must be lowered:

***Catalyst required***



# Polymerisation Catalyst

- Polymers made of alternating epoxide and CO<sub>2</sub> molecules

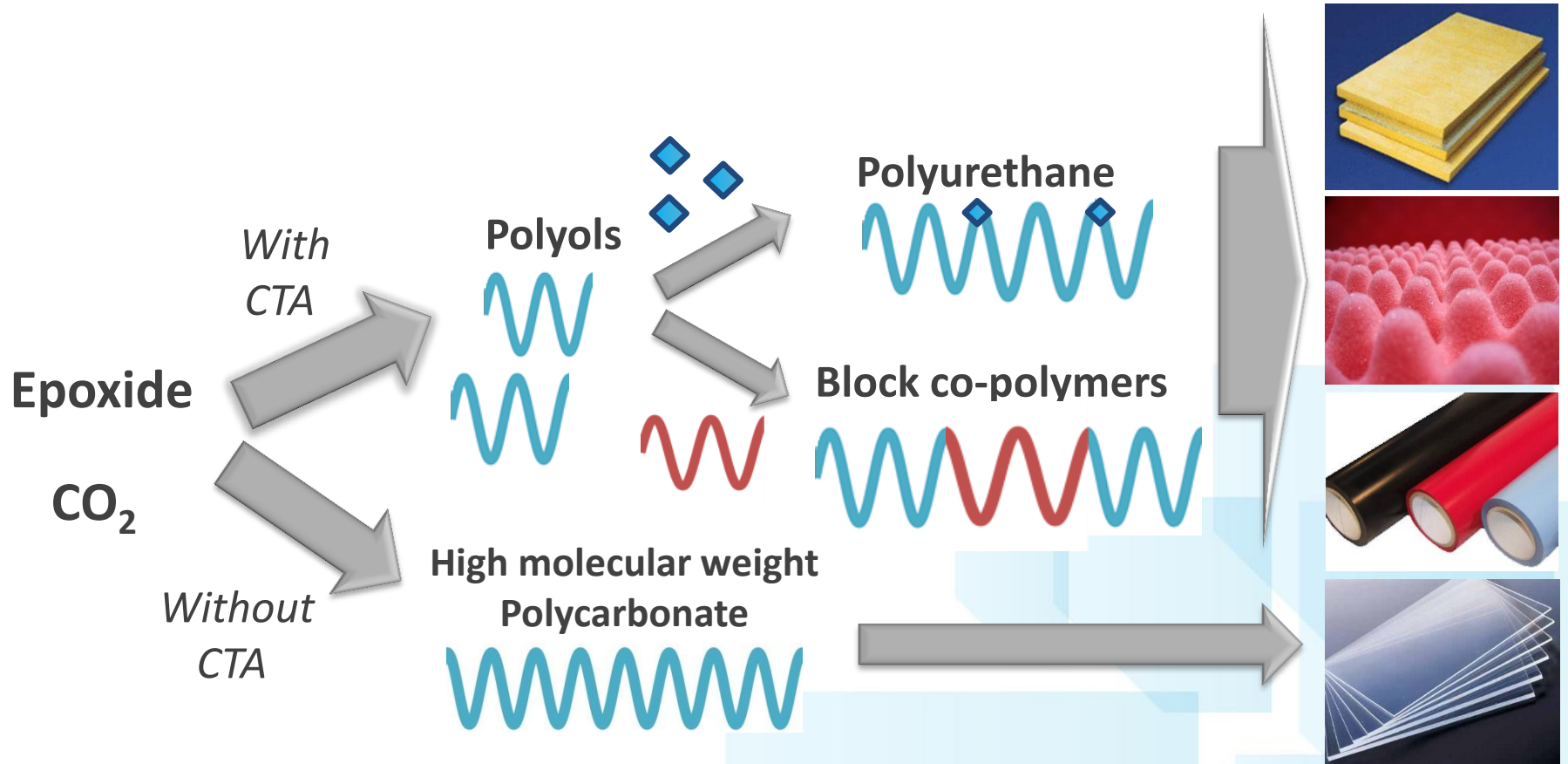


*Production of polycarbonates from CO<sub>2</sub> using an epoxide and a copolymerisation catalyst*

# Econic Catalysts

- High CO<sub>2</sub> incorporation (>99% of theoretical max)
- Low by-product formation
- Active under low (1 bar) CO<sub>2</sub> pressures
- Made from cheap, non-toxic metals (Mg, Zn)
- Cheap, easy synthesis (few steps from common bulk chemicals)
- Display high tolerance to water

# Route to Products



# Economic Opportunity

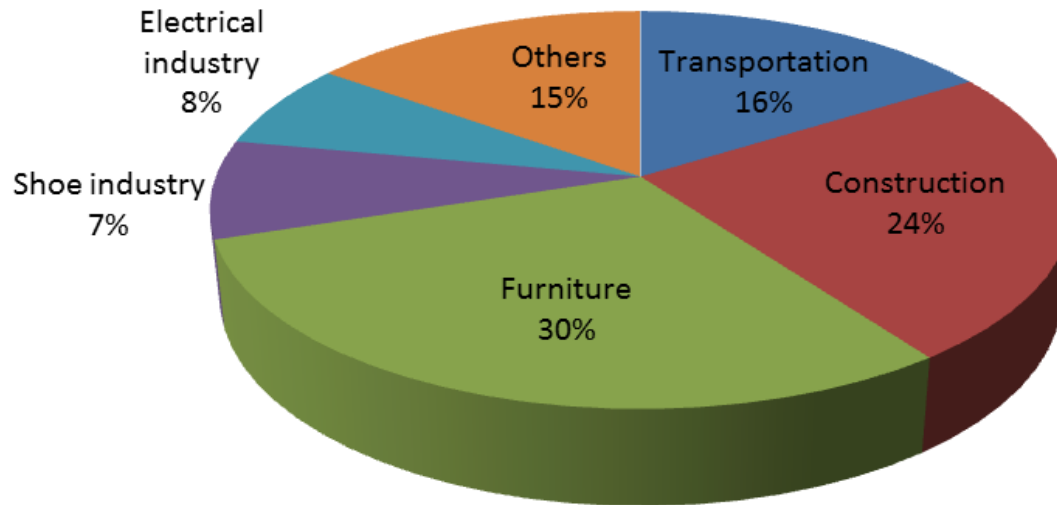
- Raw material savings for polyols

All prices in \$	Polyol	Raw material 1	Price of RM 1	Raw material 2	Price of RM 2	Total raw material cost	Potential savings
Conventional	Polypropylene oxide	PO	1 950	-	-	1 950	-
Econic Process	PCHC	CHO	2 200	CO <sub>2</sub>	50	1 550	400
	Mixed epoxide	13% PO 87% CHO	2 150	CO <sub>2</sub>	50	1 450	500
	PPC	PO	1 950	CO <sub>2</sub>	50	1 150	800

*Raw material costs for a common commercially available polyol and several Econic products: poly(propylene carbonate) (PPC), poly(cyclohexene carbonate) (PCHC) and a mixed epoxide polycarbonate (CHPPC) polyol. Costs rounded to the nearest \$50.*

# Markets

- Total world polyurethane market is 15 million t p.a. and projected to grow.
- Over 2/3<sup>rd</sup> potentially addressable by Econic polymers



*Market share for applications of polyurethanes (Kunststoffe)*



# DECC grant

- Received £100k DECC funding from competition to reduce CCS costs - November 2012
- Feasibility study with CO<sub>2</sub> from CCS pilot at Ferrybridge
- Assessment of catalyst stability to common impurities: H<sub>2</sub>O, O<sub>2</sub>, N<sub>2</sub>, SO<sub>x</sub>, NO<sub>x</sub>...



# Conclusion

- Econic is building a business on a unique suite of catalysts that offer a compelling economic solution to the environmental problem of CO<sub>2</sub> emissions.

