Converting CO_2 to Sustainable Marine Fuels Using Bifunctional Catalysts

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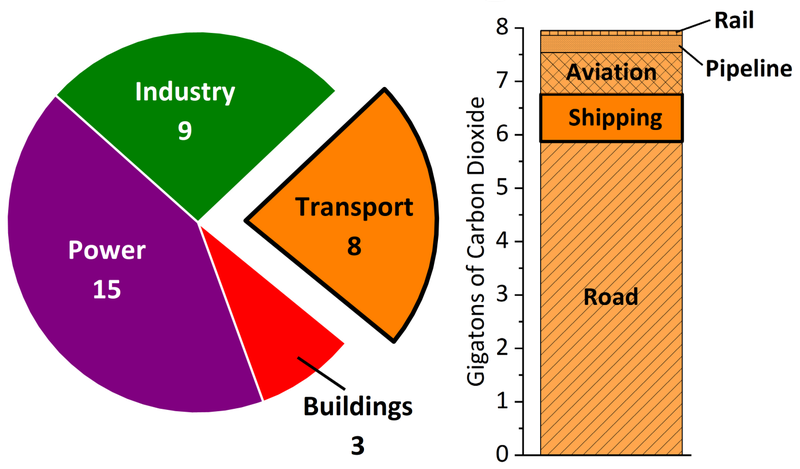
1 Decarbonising Marine Shipping



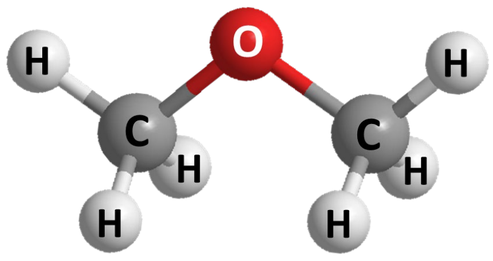
Global CO_2 emissions (Gt) in 2022 by sector[1]

- Shipping responsible for ***3% of global CO_2*** emissions
- ***Challenging to electrify*** long haul maritime shipping
- Require synthetic, ***sustainable fuels***

Vehicle compatibility with different energy sources[2]

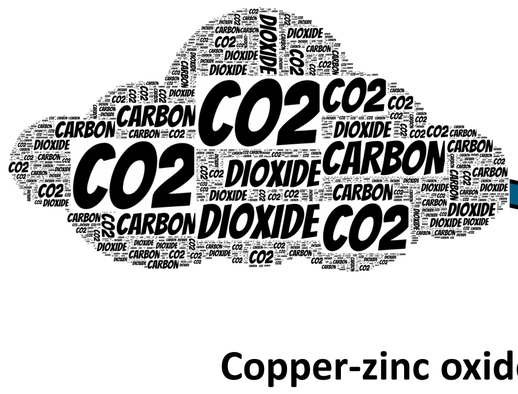
Vehicle and duty cycle compatibility		Synthetic fuels	Electricity
Aviation	Short haul	✈	✈
	Long haul		
Marine	Short journey	🚢	🚢
	Long journey		
Refuelling and distribution challenge		⛽ 📍	⛽ 📍

2 Dimethyl Ether as a Sustainable Marine Fuel



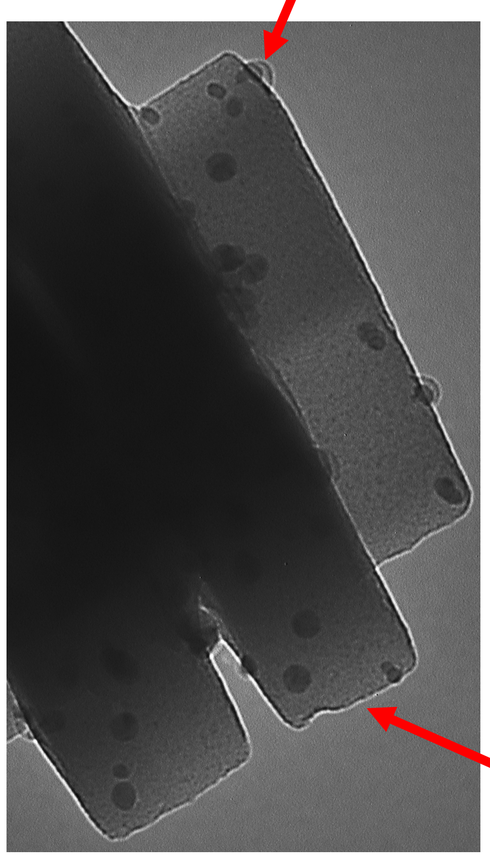
- Producible via a ***circular carbon economy*** ^{12}C
- non-carcinogenic non-corrosive, ***non-toxic***
- Burns ***more effectively*** in an engine than diesel
- Compatible with existing ***LPG infrastructure***

3 Bifunctional Catalysts for Dimethyl Ether Synthesis

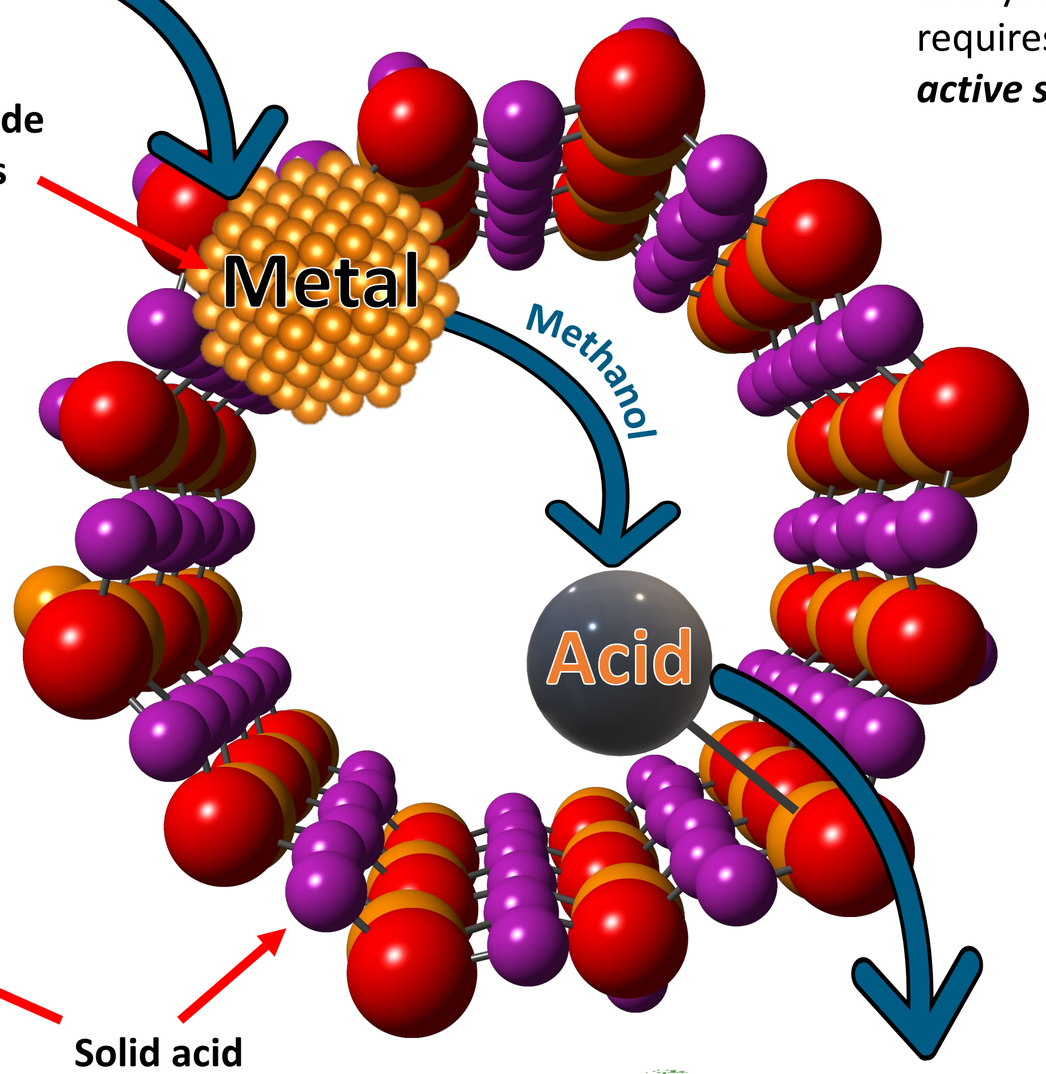


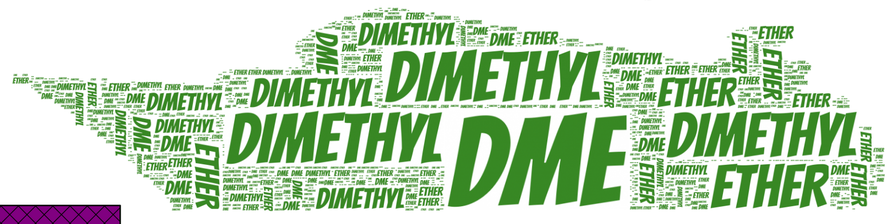
- Convert CO_2 to DME in one reactor via a methanol-mediated reaction using a bifunctional catalyst ***(reaction enabler)***
- Bifunctional catalyst requires ***two active sites***

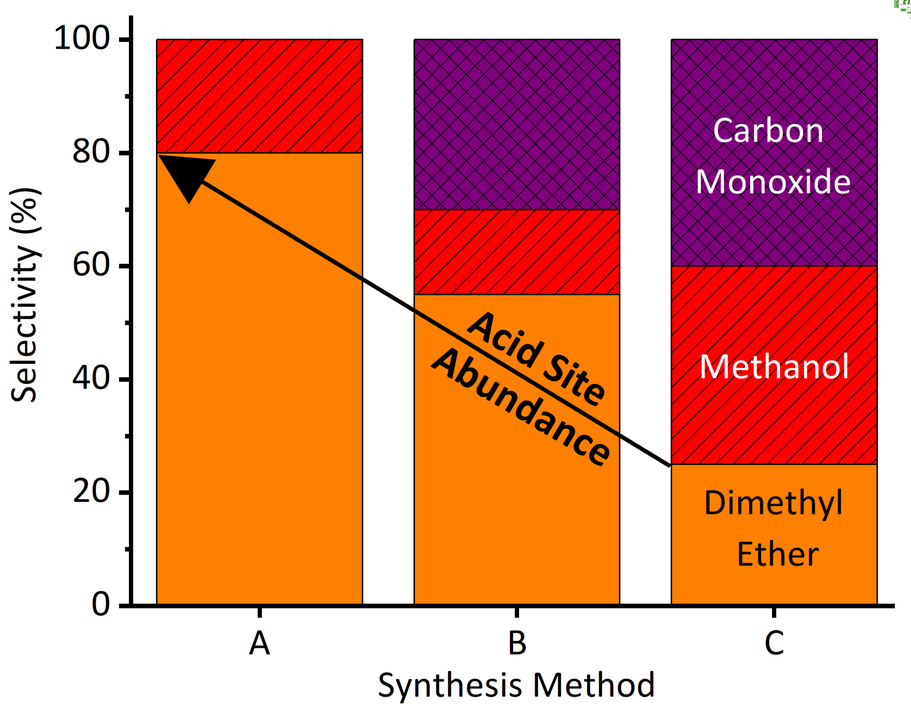
Copper-zinc oxide nanoparticles



Electron image of a cascade nanoreactor



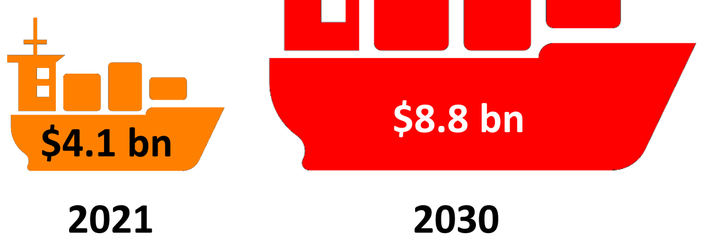




- ***Tailor synthesis*** to adjust acid active site abundance & proximity
- Catalysts with more abundant acid sites: ***higher DME selectivity*** (less waste) & no toxic CO formation
- Proximate & more abundant acid active sites increase localised water concentration which ***suppresses CO-forming reaction***

4 Summary & Outlook

- Dimethyl ether is a sustainable, ***alternative marine fuel***
- Bifunctional catalysts can convert CO_2 to DME in ***one reactor***
- Nearby & more abundant active sites give a ***cleaner reaction***
- DME market projected to ***double*** in next decade[3]



Our highly selective bifunctional catalyst could be used in a rapidly growing market

[1] International Energy Agency, CO_2 Emissions in 2022, Paris, 2023. [2] The Royal Society, *Sustainable synthetic carbon based fuels for transport: Policy briefing*, 2019.
[3] Dimethyl Ether Market Share, https://www.polarismarketresearch.com/industry-analysis/dimethyl-ether-market, (accessed 29 August 2023).

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