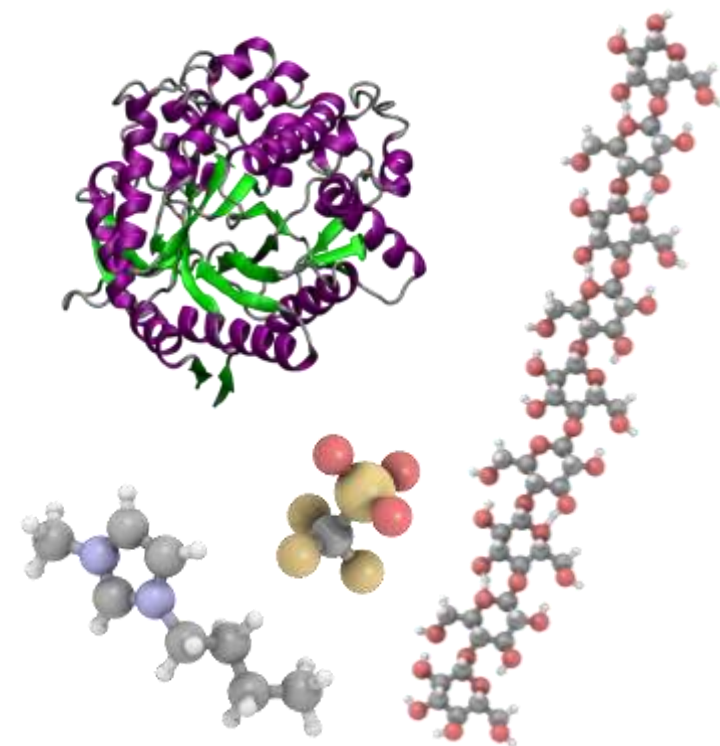
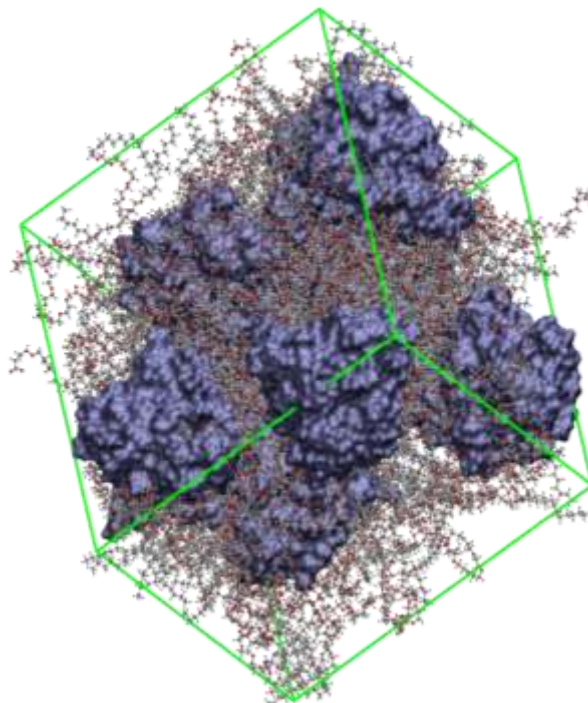
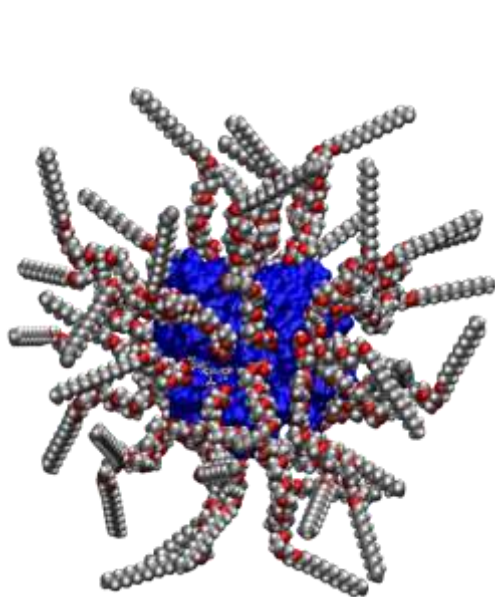


# Enhancing biocatalysis with solvent-free liquid enzymes and ionic liquids



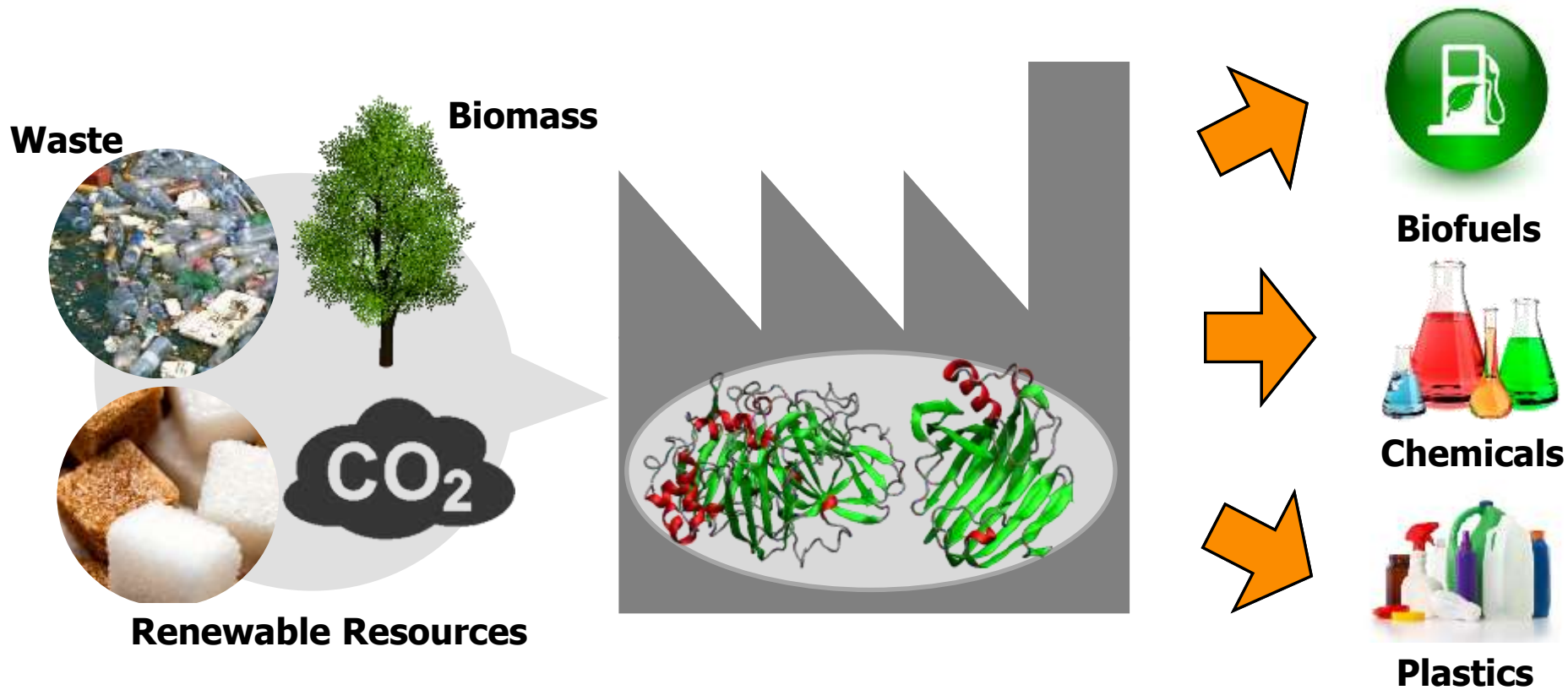
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 @apsbrogan

**KING'S**  
*College*  
**LONDON**

22<sup>nd</sup> August 2021  
*ACS Fall 2021*

[alexbrogan.co.uk/acs2021](http://alexbrogan.co.uk/acs2021)

# Biocatalysis



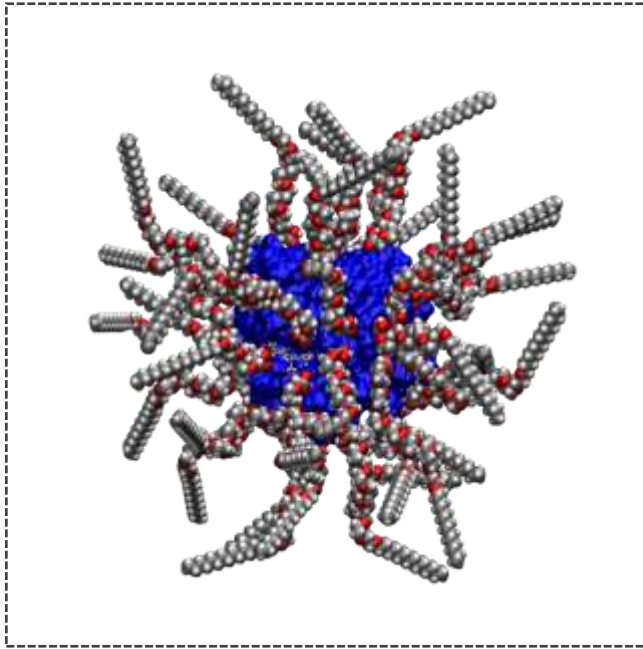
## The Challenge

Enzymes can catalyse many different industrial reactions.

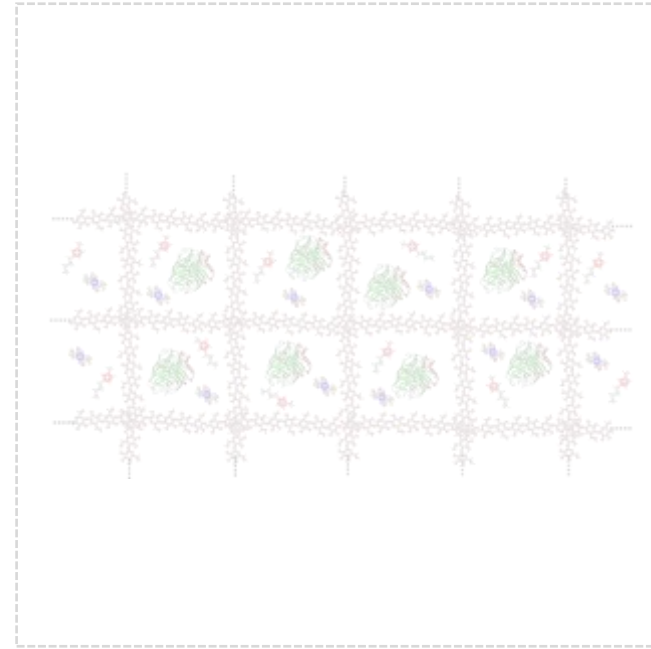
Industrial products/substrates typically require solvents other than water.

However, enzymes are often **insoluble** and **inactive** in organic solvents.

## Solvent-free Liquid Proteins



## Ionogels

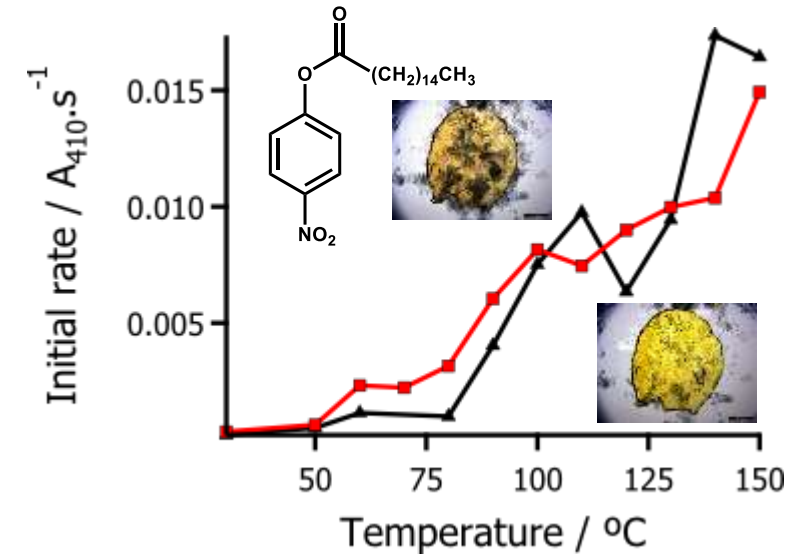
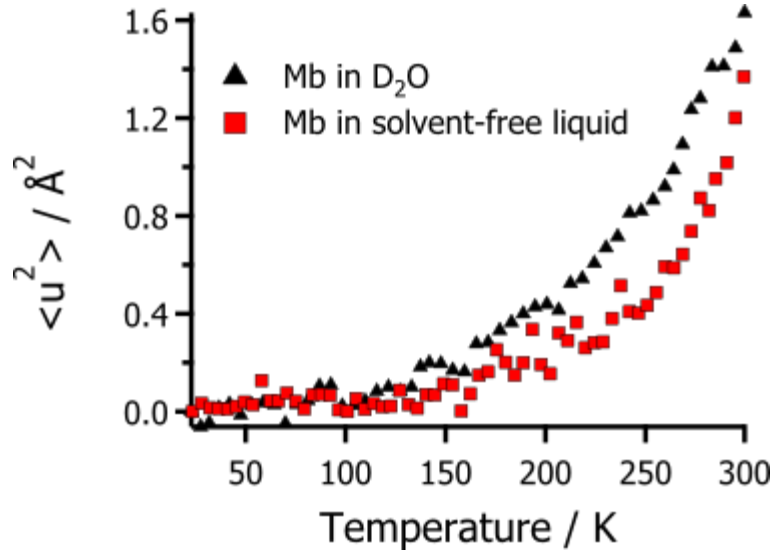
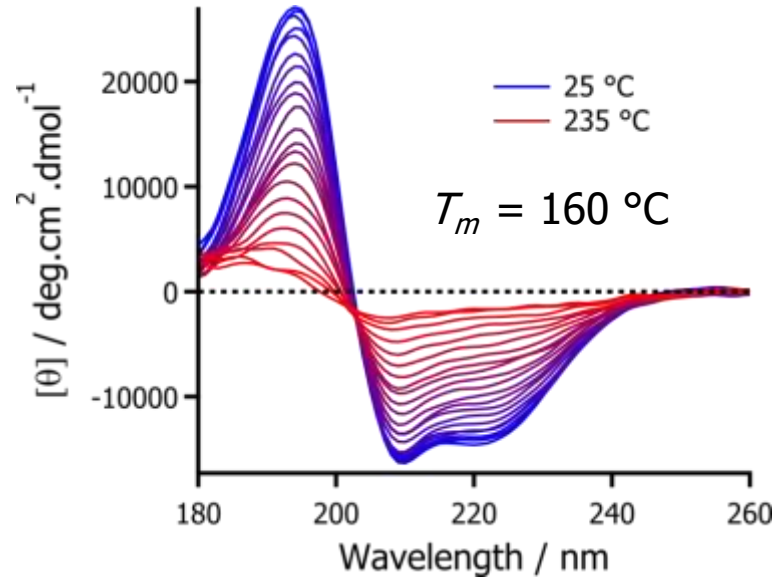


**Solubilize and stabilize enzymes in ionic liquids**

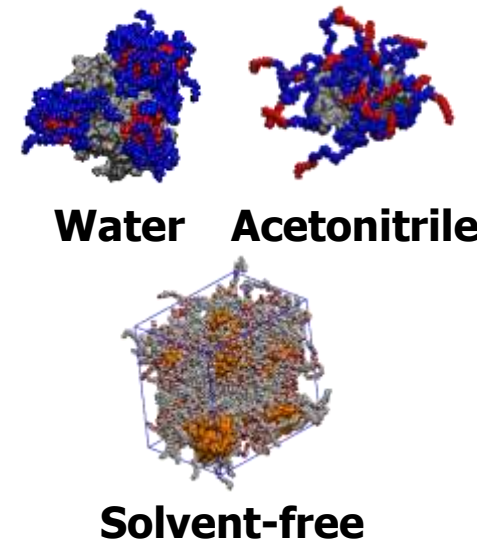
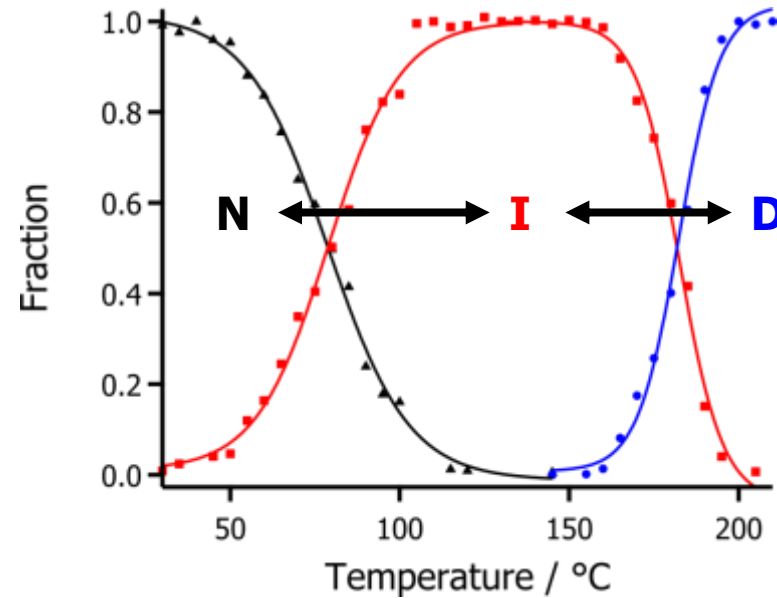




# Solvent-free Liquid Proteins

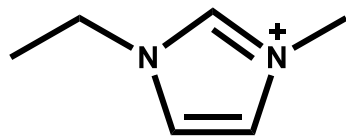


- Retained structure and hyperthermophilic-like stability.
- Protein dynamics retained within organic corona.
- Enhanced enzyme activity in absence of water.
- Protection against aggregation.



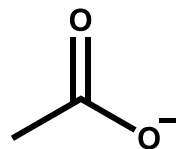
# Ionic Liquids as Designer Solvents

Cation

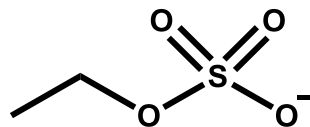


[emim]<sup>+</sup>

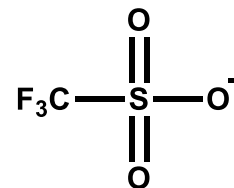
Anions



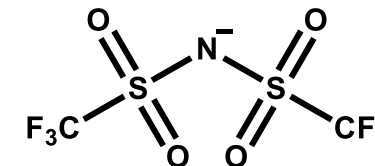
[OAc]<sup>-</sup>



[EtSO<sub>4</sub>]<sup>-</sup>



[OTf]<sup>-</sup>

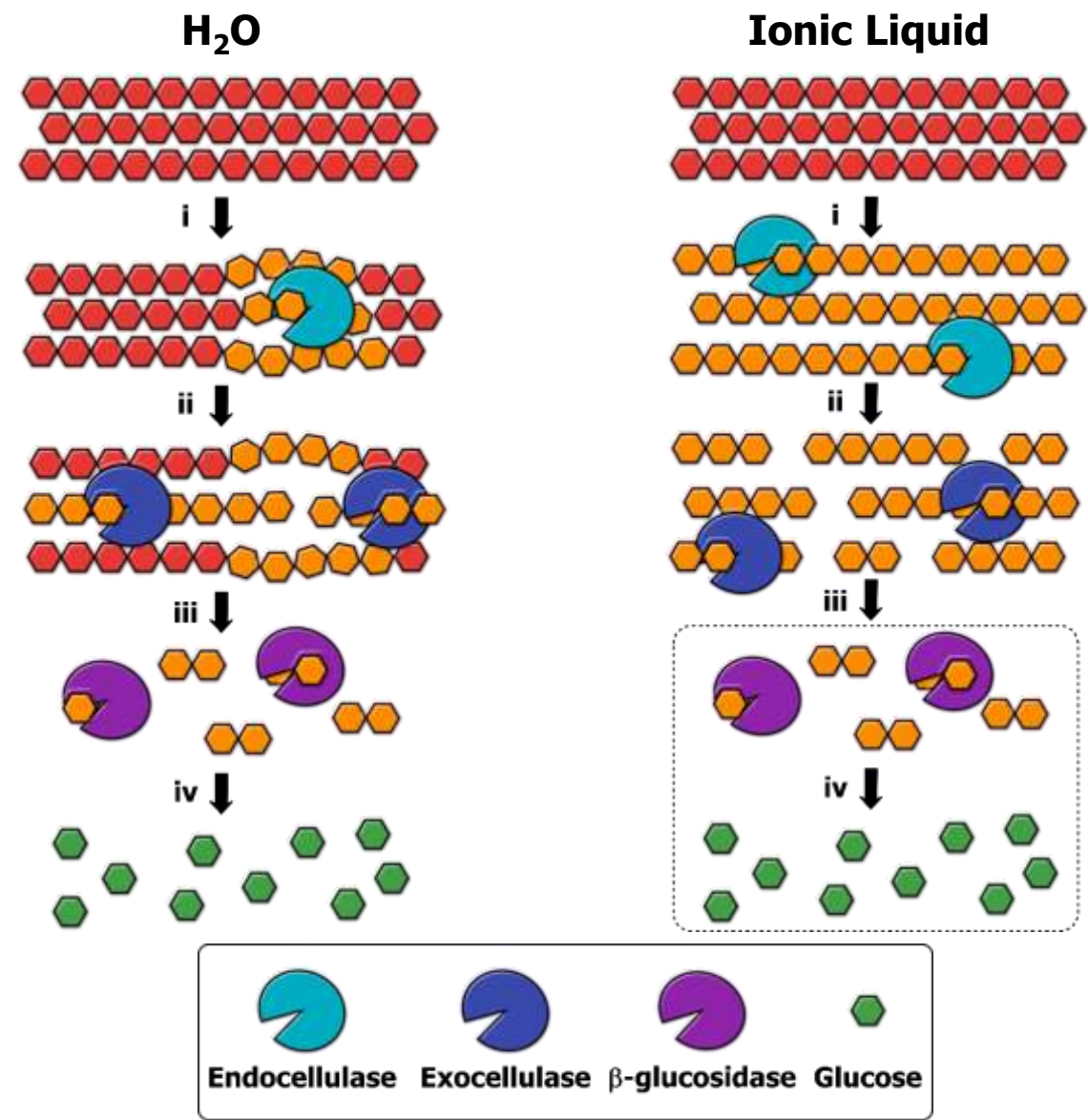


[NTf<sub>2</sub>]<sup>-</sup>

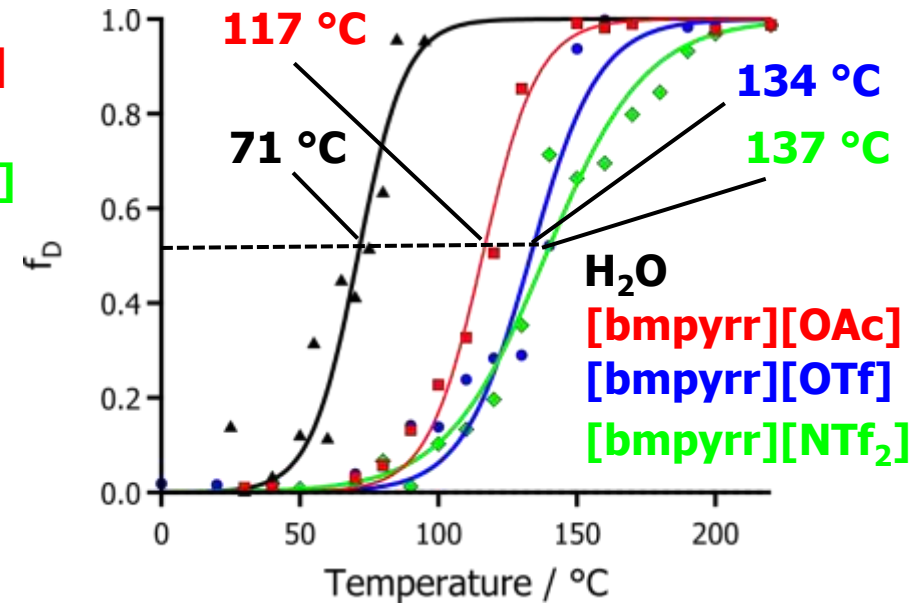
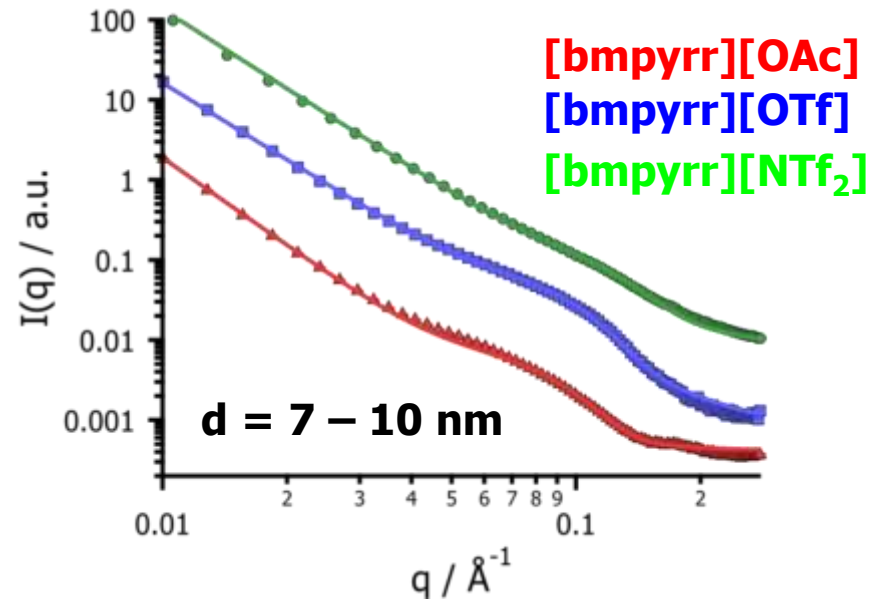
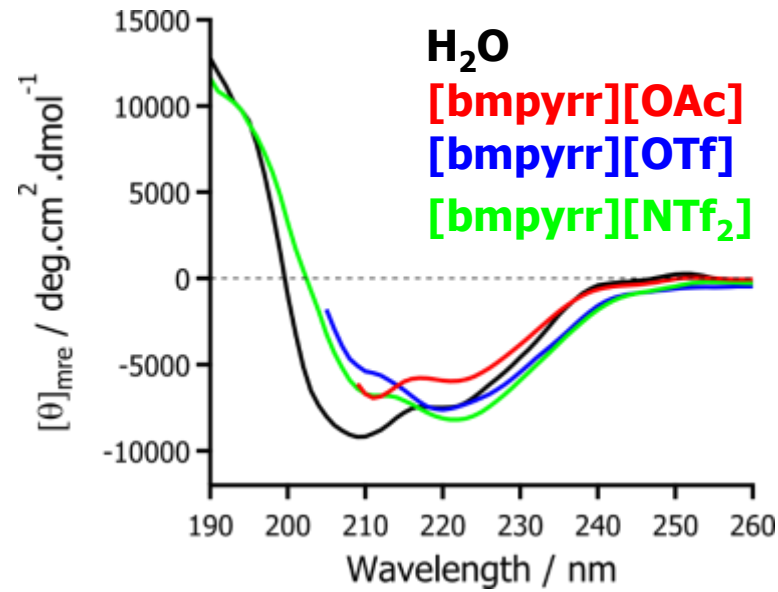


- Ionic liquids are organic solvents with highly tuneable properties.
- Can solubilize and process otherwise recalcitrant polymers.
- High thermal stability, broad electrochemical window, and negligible vapour pressure.

# Glucosidase in Cellulase Cocktails



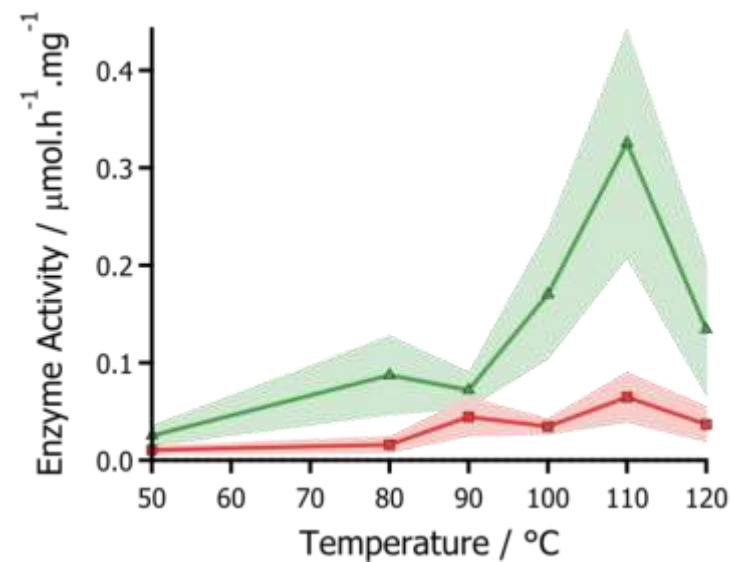
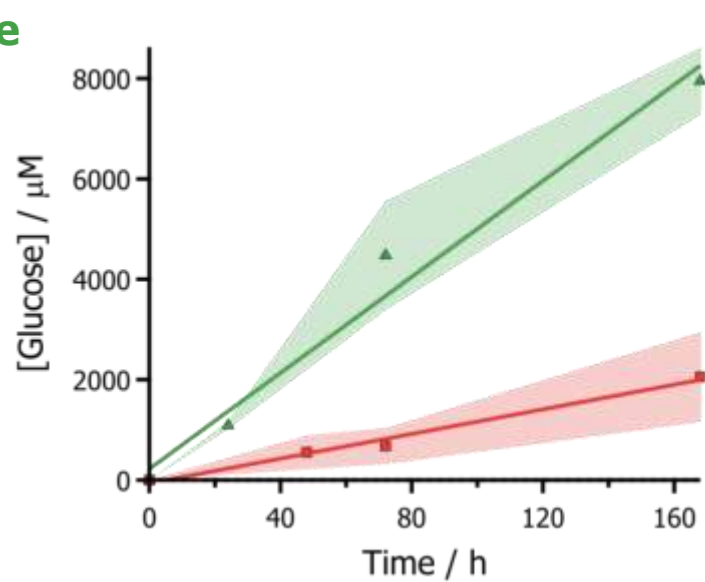
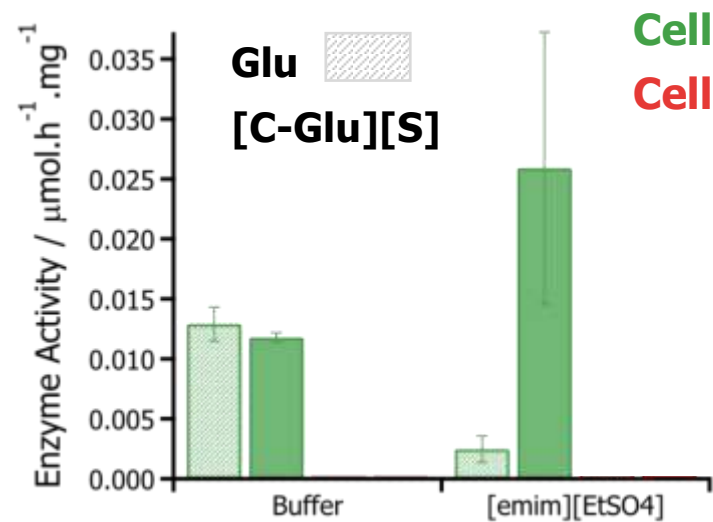
# Glucosidase Biofluids in Ionic Liquids



- Surface functionalization of glucosidase increases solubility in ionic liquids.
- Structure maintained (SRCD, SAXS)
- Highly stable in ionic liquids.

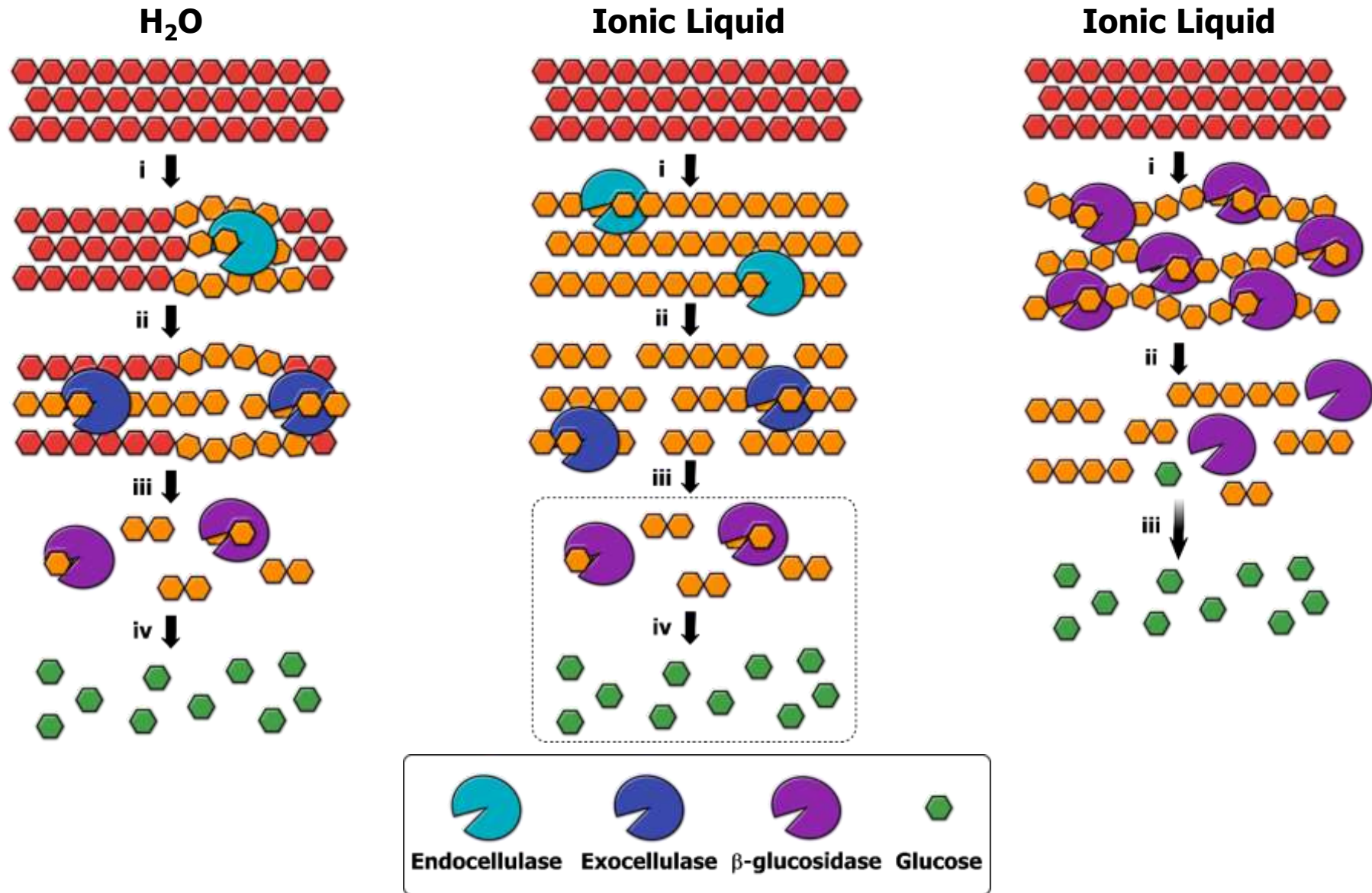


# Glucosidase Activity in Ionic Liquids

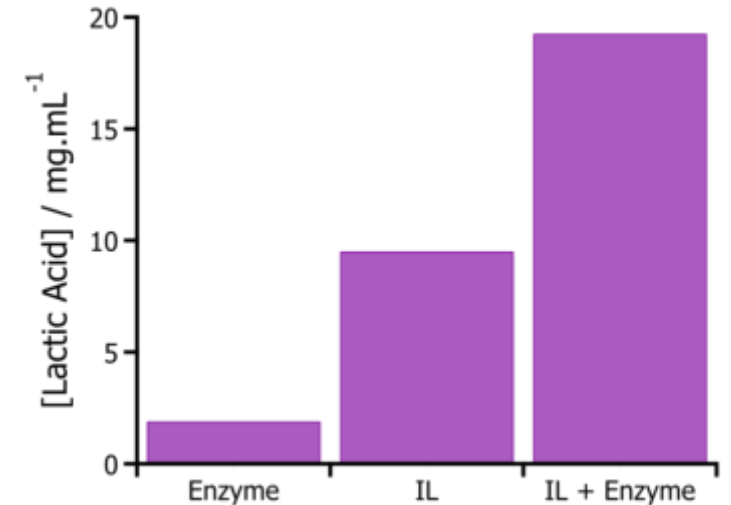
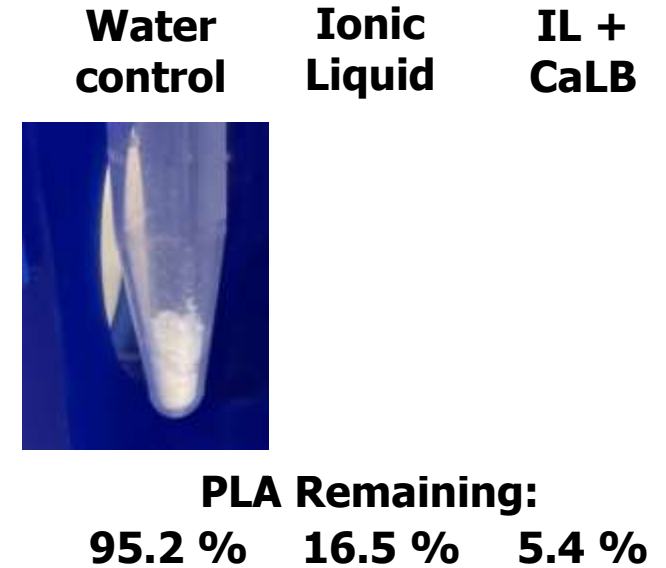
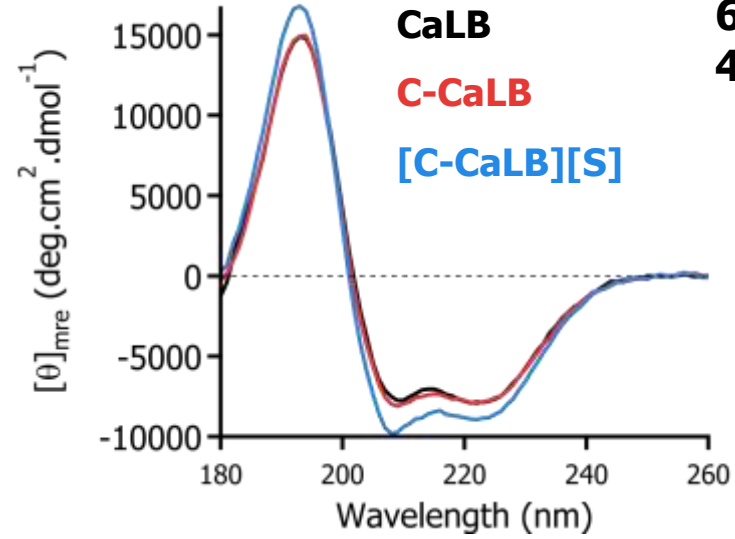
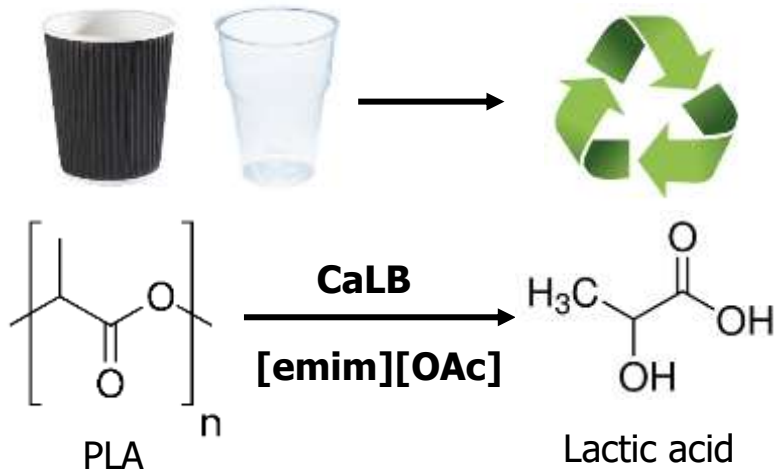


- Activity enhanced in ionic liquids – only for modified glucosidase.
- Reaction turns over at constant rate – zero order kinetics
- Enzyme activity increases by almost 30x at 110 °C

# Glucosidase Activity in Ionic Liquids



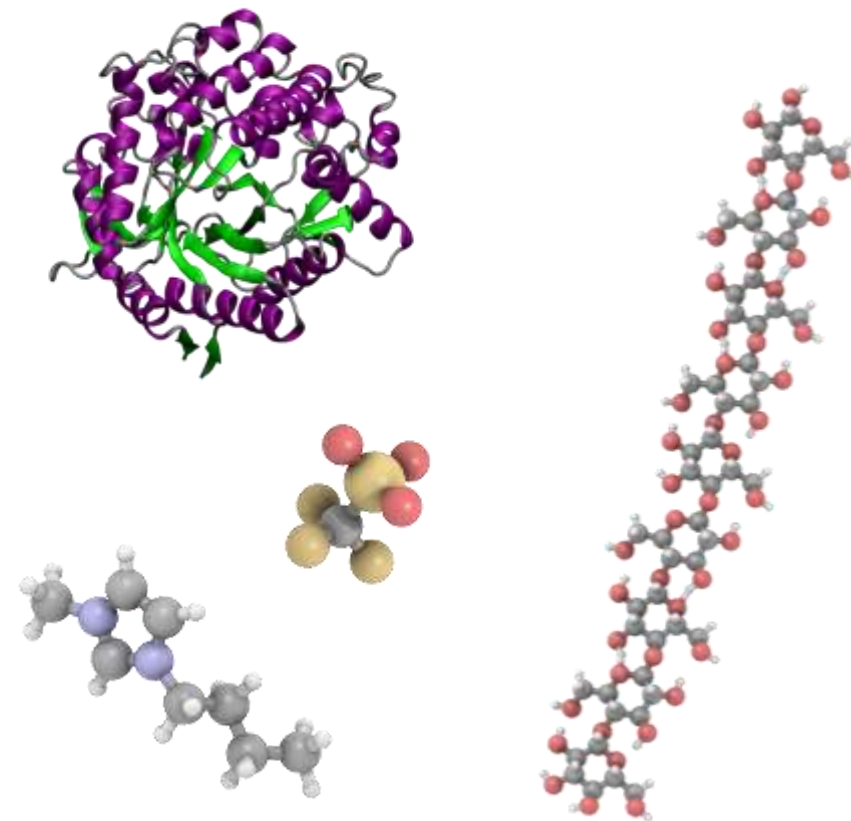
# Plastic Recycling



- Secondary structure (and activity) maintained through chemical modification.
- Mass of PLA recovered significantly reduced by ionic liquid and enzyme.
- CaLB can be used to break down PLA to monomers.

# Conclusions

- Robust synthesis for chemically modified proteins and enzymes.
- Good compatibility with ionic liquids.
- Protein structure highly conserved – in the absence of water.
- Thermal stability improves as compared to aqueous system.
- Enzyme activity of glucosidase enhanced in ionic liquids.
- Solvent-induced promiscuity of glucosidase towards cellulose.
- Promise for new routes to plastic recycling.



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[thebrogangroup.co.uk](http://thebrogangroup.co.uk)



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