Compartmentalising catalysis

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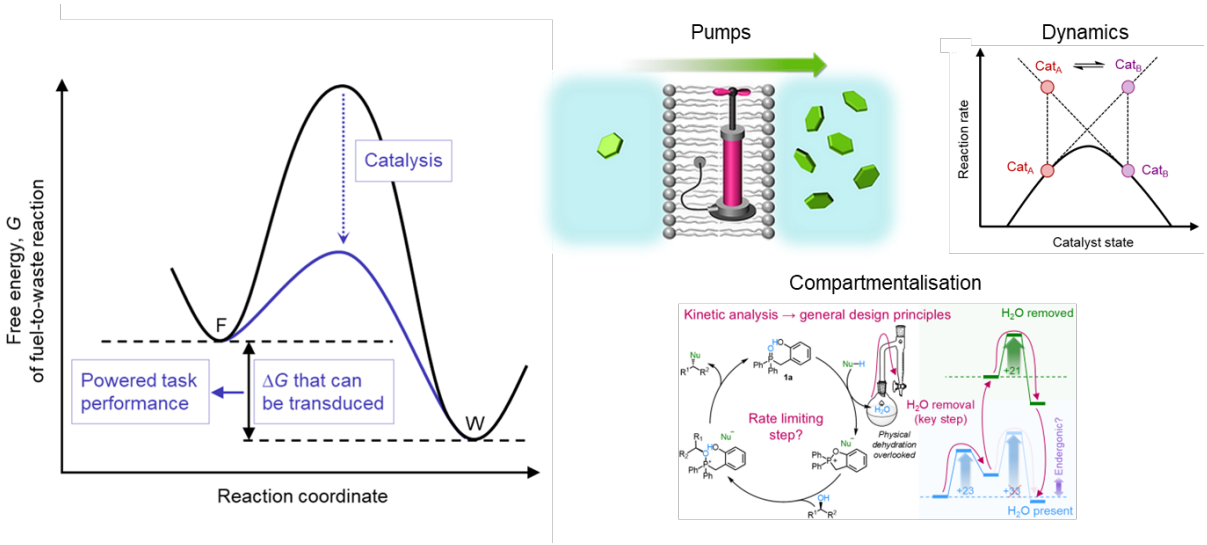
Catalysis has traditionally belonged to the realm of synthetic chemistry, where it is used to accelerate the conversion of reagents into products. But in some cases, the product is can be considered merely 'waste', and instead the real prize is the free energy released by the catalytic reaction.

This talk will explore how that free energy can be transduced to do work, and how detailed kinetic analysis allows for the design of complex, nonequilibrium behaviours.[1] We will discuss how energy from catalysis can be harnessed to pump molecules between compartments against their concentration gradient.[2] We will see how the principles that drive nonequilibrium function necessarily drive faster catalysis.[3] Finally, we will explore how the sort of detailed kinetic analysis required to explain the behaviour of molecular machines can be applied in a more traditional synthetic context to enhance the performance of a catalytic Mitsunobu reaction.[4]



1. S. Borsley, D. A. Leigh & B. M. W. Roberts, Molecular ratchets and kinetic asymmetry: giving chemistry direction. *Angew. Chem. Int. Ed.* **63**, e202400495 (2024).
2. K. Liang, F. Nicoli, S. Al Shehimy, E. Penocchio, S. Di Noja, Y. Li, C. Bonfio, S. Borsley & G. Ragazzon, Catalysis-driven active transport across a liquid membrane. *Angew. Chem. Int. Ed.* **64**, e202421234 (2025).
3. J. M. Gallagher, B. M. W. Roberts, S. Borsley & D. A. Leigh, Conformational selection accelerates catalysis by an organocatalytic molecular motor. *Chem* **10**, 1–12 (2024).
4. K. Andrews, S. Borsley, Kinetic analysis of the redox-neutral catalytic Mitsunobu reaction: dehydration, kinetic barriers and hopping between potential energy surfaces. *J. Am. Chem. Soc.* **147**, 18240–18248 (2025).

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Stefan obtained his PhD from the University of St Andrews under the supervision of Dr Euan Kay, followed by postdoctoral positions at the University of Edinburgh with Prof. Scott Cockroft and the University of Manchester with Prof. David Leigh FRS. In late 2023, Stefan joined Durham University on a Royal Society University Research Fellowship. His group explores nonequilibrium processes and non-linear kinetics, particularly