Intrinsic Enzymatic Properties Modulate the Self-Propulsion of Micromotors

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Bio-catalytic micro- and nanomotors self-propel by the enzymatic conversion of substrates into products.[1] Enzymes offer a combination of biocompatibility, bioavailability and versatility, making it a promising tool for certain biomedical applications.[2] Despite the advances in the field, the fundamental aspects underlying enzyme-powered active motion have rarely been studied, and need to be addressed to make implementations more feasible. We focus our research on the study of the fundamental aspects that rule the active motion of enzymatic micro- and nanomotors,[3] such as the role of the enzyme intrinsic properties.[4]

We explore the versatility of such systems by studying the powering capacity of a library of enzymes to propel silica-based micromotors: urease, acetylcholinesterase, glucose oxidase and aldolase. We study how their turnover number and conformational dynamics affect the self-propulsion, combining both an experimental and molecular dynamics (MD) simulations approach. Results show that the motion behavior is strongly dependent on the enzyme type.

We conclude that the conformational changes are a precondition for urease catalysis, and that the rate of catalysis is essential and directly related to active motion. Future research will be focused on studying the effect of extrinsic parameters such as the media properties and composition.

Figures

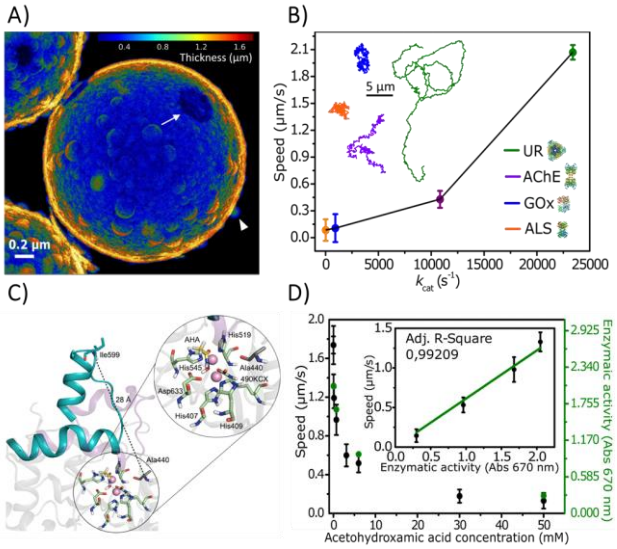

Figure 1. (A) TEM micrograph of a microcapsule colored depending on thickness. Hole detection (arrows) and silica bulks (arrowheads) detection. (B) Speed vs. turnover number (k_{cat}) of different enzymatic micromotors (urease, acetylcholinesterase, glucose oxidase and aldolase). Inset: Trajectories of the enzymatic micromotors. (C) Molecular dynamic simulation (MDS) of urease with acetohydroxamic acid (AHA) stabilizing the flap in wide-open state (teal). (D) Speed of UR-HSMM and enzymatic activity (Abs 670 nm) vs AHA concentration in 500 mM urea. Inset: linear correlation of speed and enzymatic activity.

References

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