Artificial molecular motors probing the stiffness of membranes

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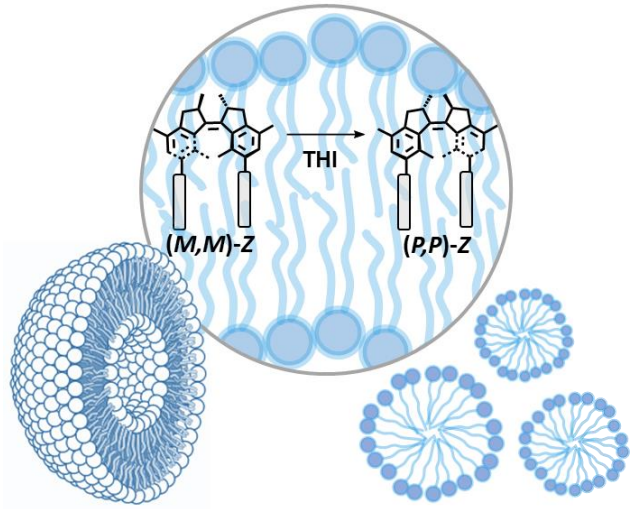
The ability of a lipid bilayer to bend and deform is directly related to its stiffness, and it is essential to the proper operation of its functional mechanics. Micropipette aspiration, fluctuation spectroscopy, atomic force microscopy, and X-ray diffraction are all techniques that can be used to investigate the membrane stiffness; however, they all require specialized equipment and only provide information on the stiffness of individual membranes, be it in single cells or vesicles.

In previous research on harnessing the rotation of molecular motors to control the movement of soft matter[1], we observed that the rotational frequency of overcrowded alkene motors is significantly influenced by the physical properties of their environment[2]. We therefore set out to use molecular motors as a probe for the stiffness of lipid bilayers.

We synthesized first-generation rotary motors and embedded them in phospholipid membranes. Next, we investigated the kinetics of motor thermal helix inversion, which is the rate limiting step in the four-step rotation cycle, by using UV-visible spectroscopy. The results show that molecular motor rotates slower when the stiffness and order of the bilayer is increased. Further, our work extended to studying the rotation frequency of motors in micelles with varying degrees of organization, and we demonstrate that the rotation frequency of these overcrowded alkene motors is dependent to the organization of their environment.

Our research into the relationship between molecular motor rotation speed and membrane stiffness paves the way for out of equilibrium functional systems in which molecular machines drive soft matter, which in turn affects the molecular machines; thereby establishing a feedback loop between the molecular and macroscopic levels.



References

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[2] Ryabchun, A.; Lancia, F.; Chen, J.; Morozov, D.; Feringa, B. L.; Katsonis, N., Helix Inversion Controlled by Molecular Motors in Multistate Liquid Crystals. *Advanced Materials* **2020**, *32* (47), 2004420.