Remote Control and High-resolution Measurement for Molecular Motors Research

by

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Abstract:

Engineering molecular motors with dynamically controllable properties will allow selective perturbation of mechanical processes in vivo. We previously constructed myosin motors that respond to a chemical signal by reversing their direction of motion along the polarized actin filament1. To expand the potential applications of controllable molecular motors, we have now developed myosins that shift gears in response to blue light illumination. Using structure-guided protein engineering, we have incorporated LOV photoreceptor domains into the lever arms of chimeric myosins, resulting in motors that robustly speed up, slow down, or switch directions upon illumination. These genetically encoded motors should be directly deployable inside living cells.

Simultaneous measurements of DNA twist and extension have been used to measure physical properties of the double helix and to characterize structural dynamics and mechanochemistry in nucleoprotein complexes2,3. We have developed gold rotor bead tracking (AuRBT) to overcome remaining limitations in the spatiotemporal resolution of previous techniques. We have tested our methodology with benchmark measurements of DNA physical properties, and have implemented RBT torque spectroscopy4 with gold probes to achieve large improvements in Brownian-limited torque resolution. Finally, we have used AuRBT to observe the structural dynamics of the DNA gyrase motor, examining conformational transitions at previously inaccessible timescales.

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