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Optical control of fast and processive engineered myosins in vitro and in living cells

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Spatiotemporal control of cytoskeletal transport can provide new possibilities for dissecting cellular processes and for constructing complex artificial devices. Optogenetic approaches have been used for both controlled recruitment of motors to cellular cargos [1] and direct modulation of motor speed and direction [2]. Previous designs for light-activated gearshifting [2] were non-processive, and suffered from either low velocities or modest degrees of velocity modulation in response to light, limiting applications in cell biology and in devices. We have now engineered (i) non-processive myosin motors that combine large optical modulation depths with high velocities and (ii) processive myosin motors with optically controllable directionality. We have characterized a series of optimized constructs using in vitro motility assays of propelled actin filaments, single-molecule tracking of processive complexes, and live cell imaging of individual motors tagged with fluorescent protein arrays [3]. An extended set of optogenetic motors, together with RNA-protein hybrid motors controlled by oligonucleotide signals [4], will provide a diverse toolkit for programmable control of nanoscale transport and force generation.
1. van Bergeijk, et al. (2015) Nature 518; 2. Nakamura et al. (2014) Nat Nanotechnol 9; 3. Ghosh et al. (2019) Nat Chem Bio 15; 4. Omabegho et al. (2018) Nat Nanotechnol 13

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