Dynamic systems mimicking the systemic complexity in biology

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Abstract

One of the most inherent and interesting features of living systems is their adaptability to show complex behavior, in response to a variety of signals. Among these behaviors, autonomous motion has been an important source of inspiration for scientists who, over the years, have created a variety of synthetic motor systems, imitating biological motility[1]. For example, molecular motors[2], micro- and nanoscale sized Janus motors[3], self-assembled polymeric motors[4], movable tubules and rods[5] have been developed. Regardless of the excellent performance of these motor systems, there is a fundamental difference in the way movement is regulated in synthetic and natural systems. Cellular autonomous motion (e.g., vesicular transport and motility), displays adaptive features as a result of competing transient activation and deactivation processes, which are governed by enzyme-mediated energy input and consumption, and molecular interactions. Such dynamic processes are also referred to as out-of-equilibrium or dissipative; mimicking these behaviors in synthetic systems has recently drawn much attention from the scientific community. Introducing transient behavior into synthetic molecular or nanoscaled systems has been demonstrated for active materials with unique properties such as dissipative fibres[6], transient peptide hydrogels, vesicles or microcapsules[7], and non-equilibrium molecular recognition and colloidal systems[8]. In a stepwise fashion, we couple motility to a dynamic process, which is maintained by transient events[9]. This lecture will therefore focus on how we translate dynamic processes into motion – on both nano and micro scale.

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Figures

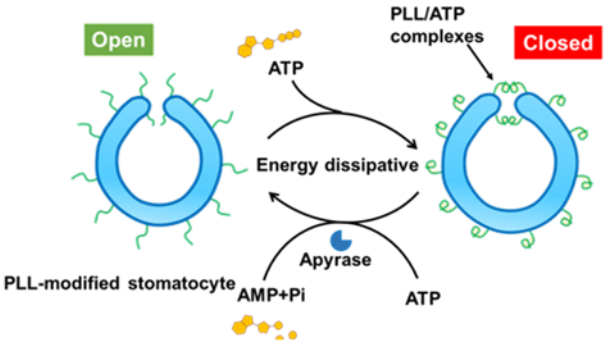

Figure 1. Schematic representation of the transient deactivation and activation of a stomatocyte nanosystem mediated by ATP.