Designed Negative Feedback from Catalytic Non-Equilibrium Assemblies

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Abstract:
Structures in living systems manipulate the high energy ester bonds of chemical fuels to create dissipative assemblies which can access emergent functions such as catalysis. Highly dynamic and complex systems of microtubules undergo substrate driven change of conformation which leads to polymerization. Through this talk, I will show our recent results which demonstrate through a simple model system, the realization of a substrate driven dissipative self-assembled state by utilizing the catalytic effects of histidines on the kinetically stable ester bond. Out of equilibrium state is achieved due to two distinct pathways both catalyzed by histidine, installed in the simple lipid based structure. Firstly, histidine facilitates the ester bond formation, which then rapidly coassembles to form a self-supporting gel. Also, out of equilibrium state is realized due to the emergence of cooperative catalysis by the proximal histidines in the assembled state, driving the second pathway and resulting in disassembly to sol. This simple system models the structural journey seen in microtubule formation, where the emergence of catalytic roles in assembled state results in the dynamic instability and disassembly of filaments. Further, I will share the latest data on temporal control of function by these artificial transient systems.