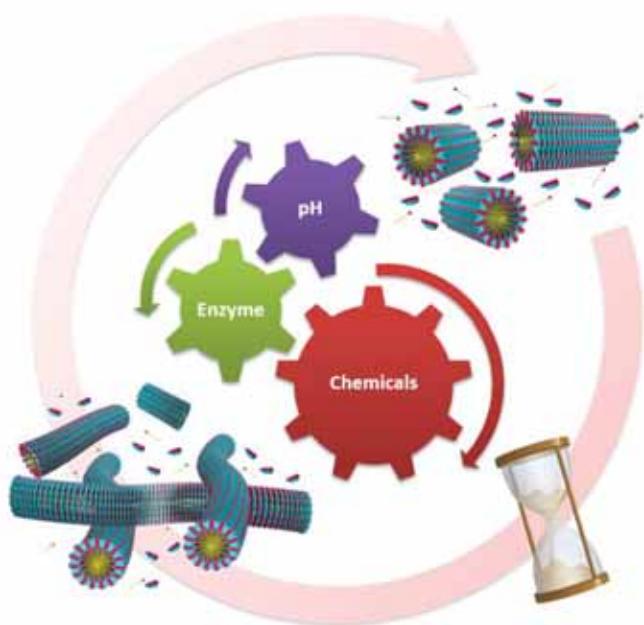


Fuel-Driven Temporal Supramolecular Polymers

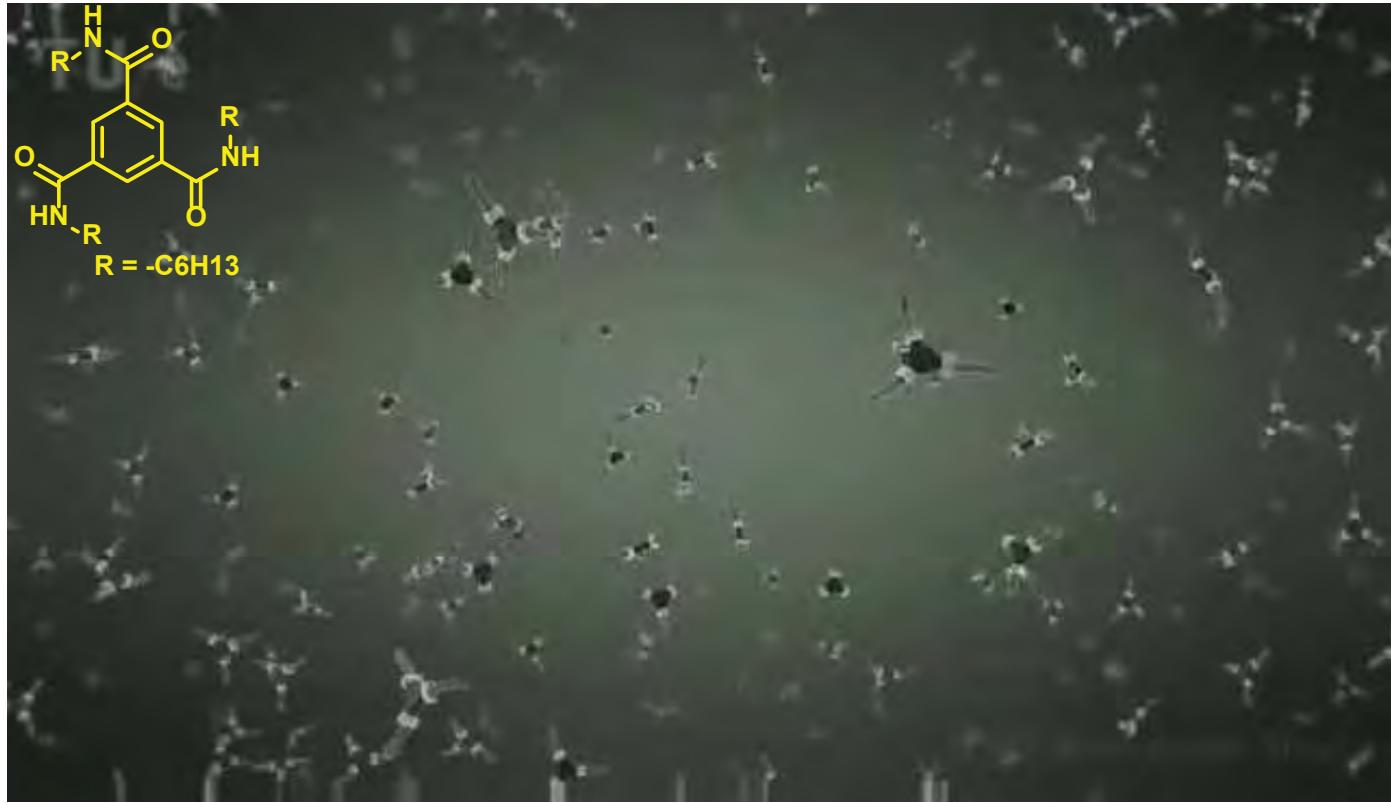
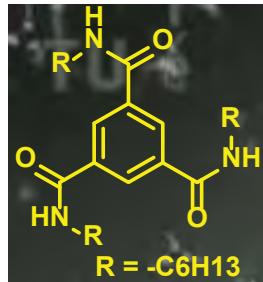
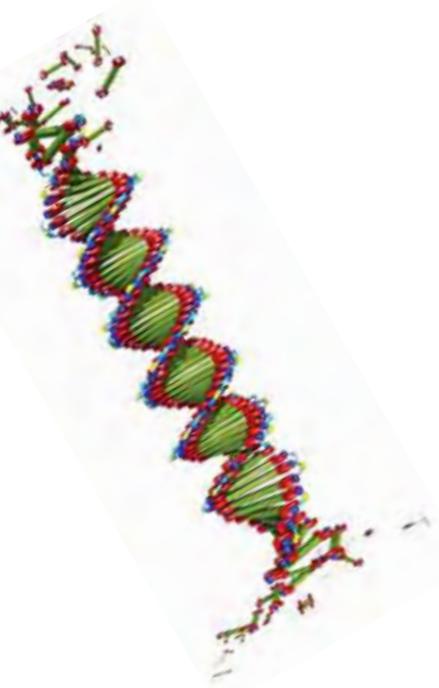
Living and Non-Equilibrium
Supramolecular Polymerization



Subi J. George

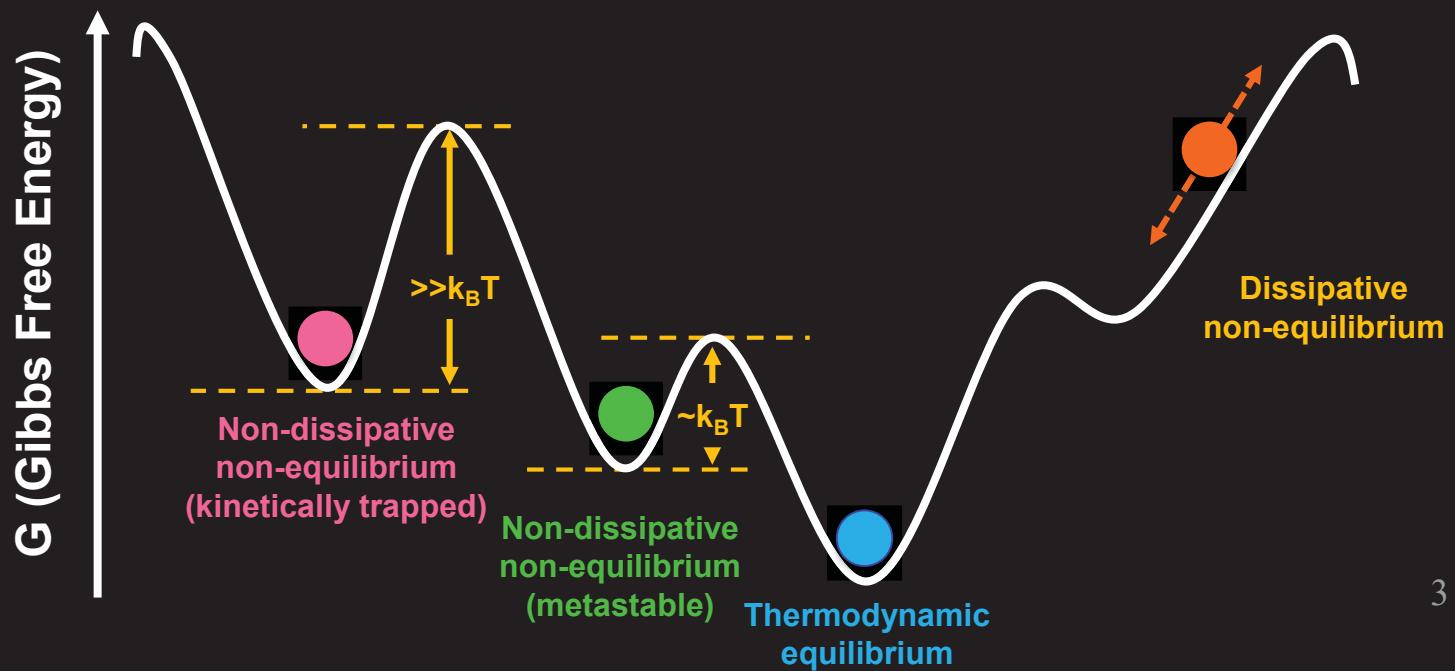
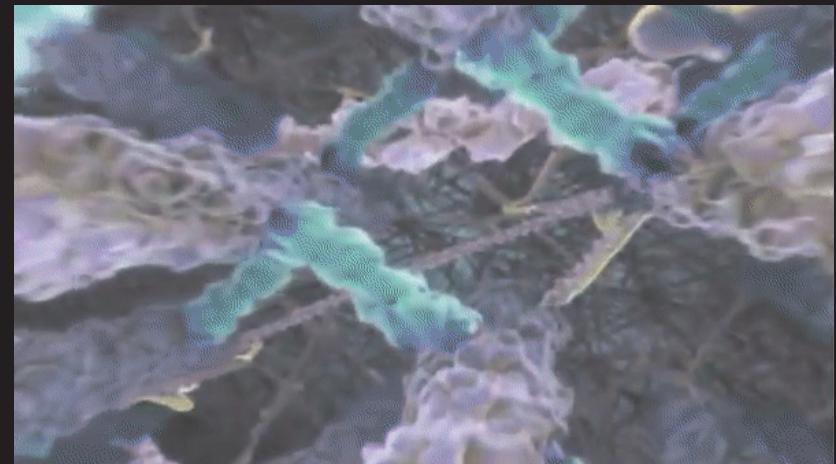
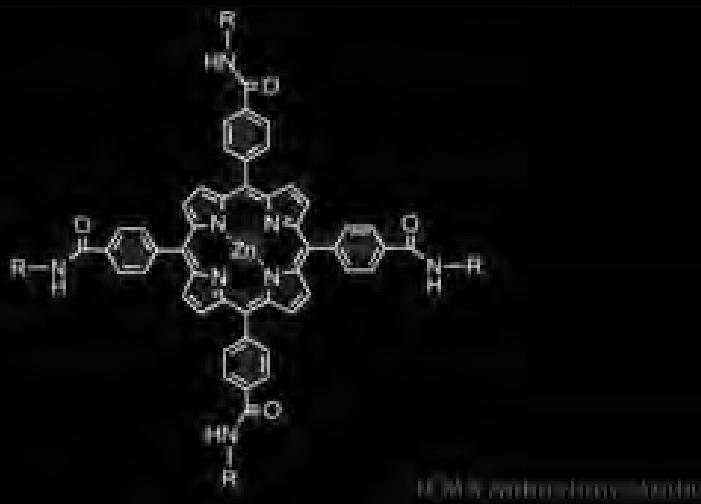


Dynamic Supramolecular Polymers

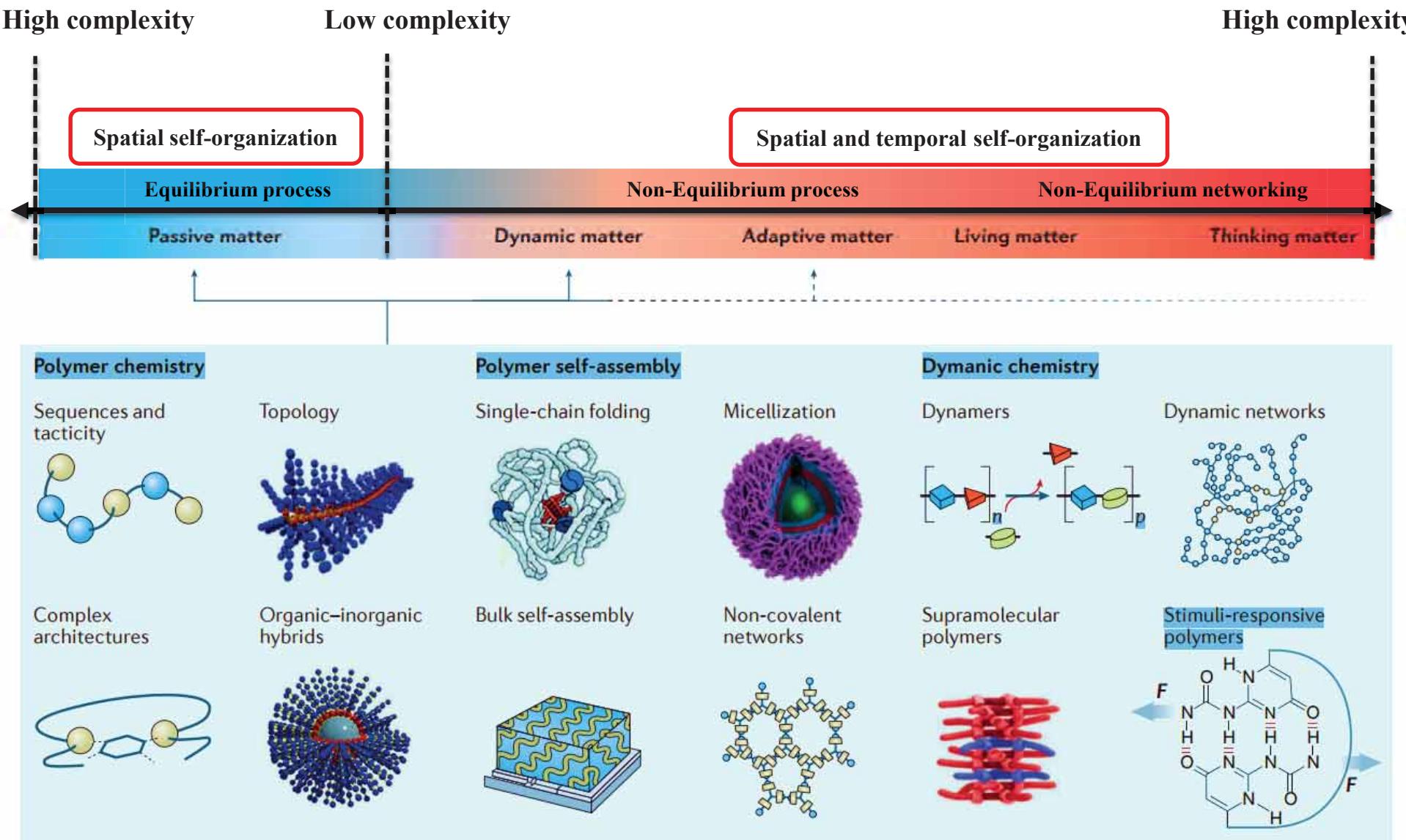


Temporal State of Supramolecular Polymers

TU/e



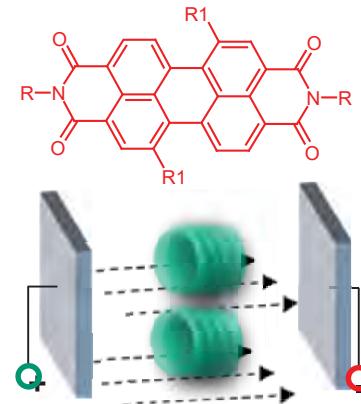
Future complex soft-matter and materials...



π -Conjugated Semi-Conducting Supramolecular Polymers

Structural control is necessary for enhanced function in supramolecular devices

- Control the dimensions of the Assembly
- Multi-Block Systems
- Integration onto Devices

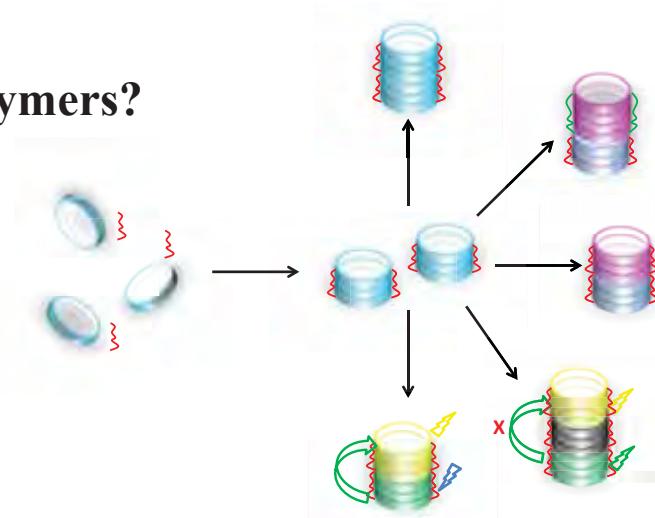


Multi-component and Mono-disperse Supramolecular Polymers?

Kinetic Controlled-

Living Supramolecular Polymerization?

Transient Materials



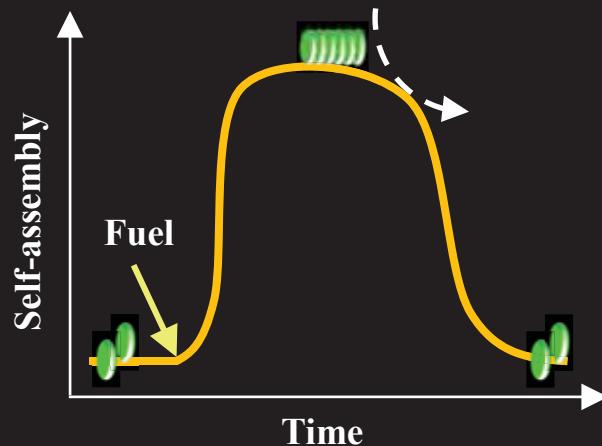
Ankit Jain and Subi George

“New Directions in Supramolecular Electronics”, Materials Today 2015, 18, 206-214

“Supramolecular electronics: Meshing organic nanowires”, Nature Nanotechnology, 2016, 11, 843

Non-equilibrium/ Transient Supramolecular Polymers

Living Supramolecular Polymers



Programmable functions

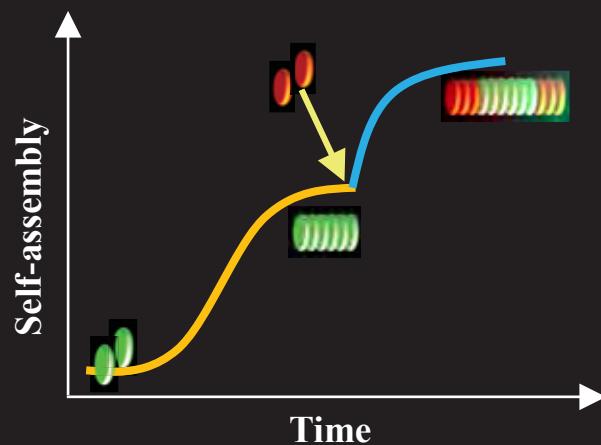
Nature Commun. 2014, 5, 5793

Angew. Chem. Int. Ed. 2017, 56, 1329–1333

J. Am. Chem. Soc., 2017, 139, 16568–16575

Chem. Sci. 2017, 8, 6030-6036

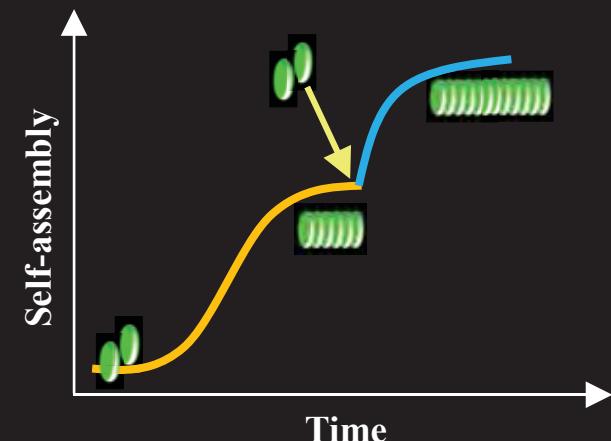
**Multi-component
Supramolecular
Co-polymerization**



Bull. Chem. Soc. of Jpn., 2018, 91, 687-699 (Invited Commemorative Account)

RSC Adv., 2018, 8, 18913–18925 (Critical Review, CFG special issue)

Angew. Chem. Int. Ed. 2018 (Invited Review, Under Preparation)



Controlled size and narrow dispersity

Nature Commun., 2018, 9, 1295

J. Am. Chem. Soc. 2017, 139, 13867-13875

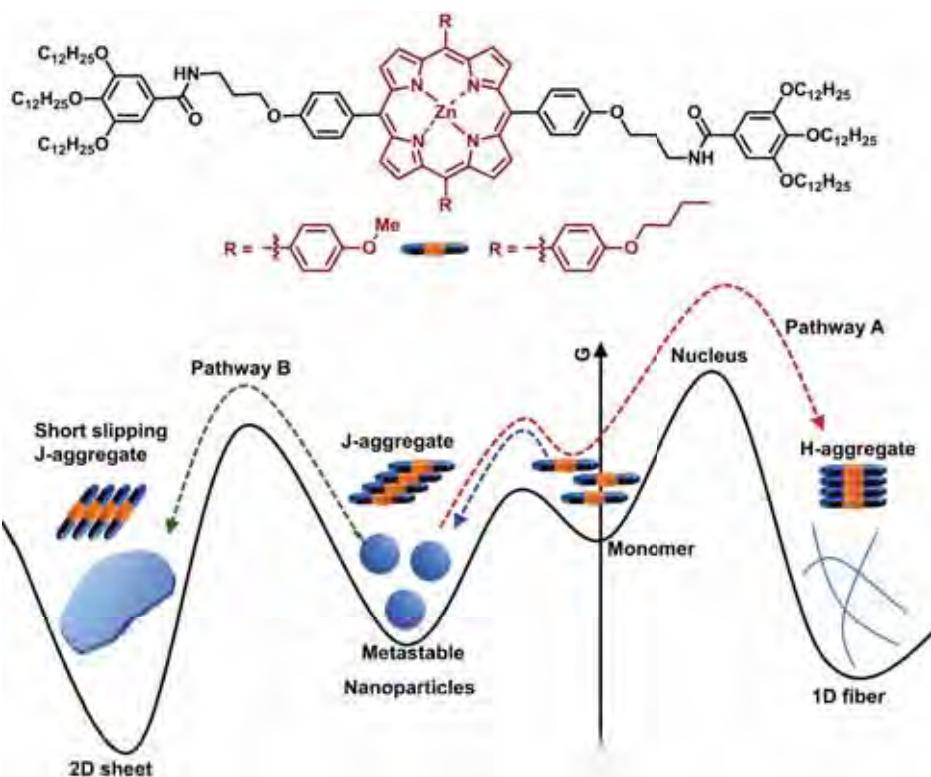
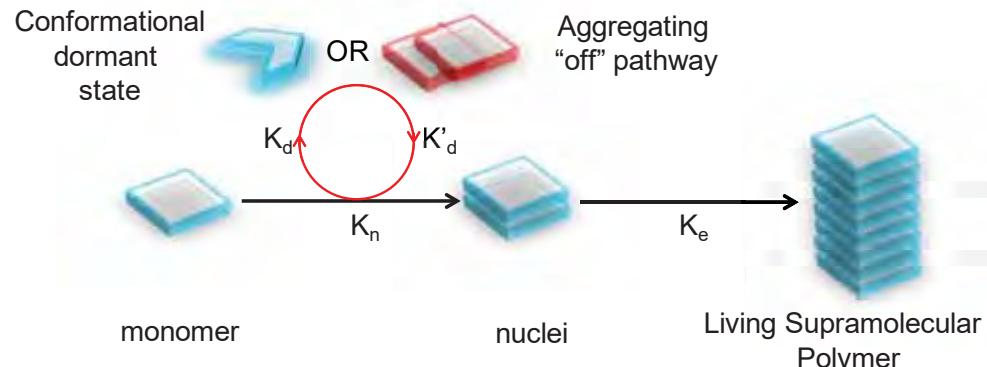
Angew. Chem. Int. Ed., 2017, 56, 13767-13771

Nature Commun., 2019, 10, 450

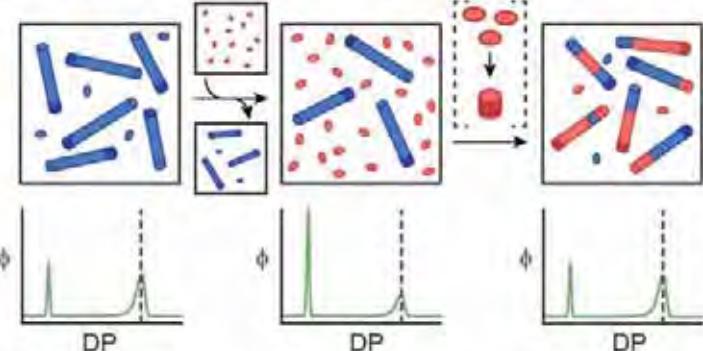
Nature Commun., 2019 (Under révision)

Manuscript under préparation

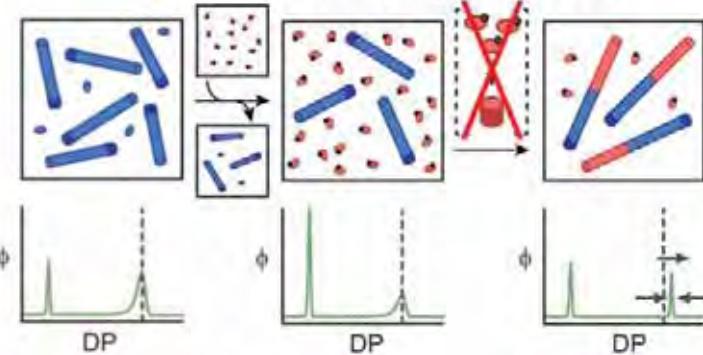
Living Supramolecular Polymers!



a) Classical cooperative polymerization



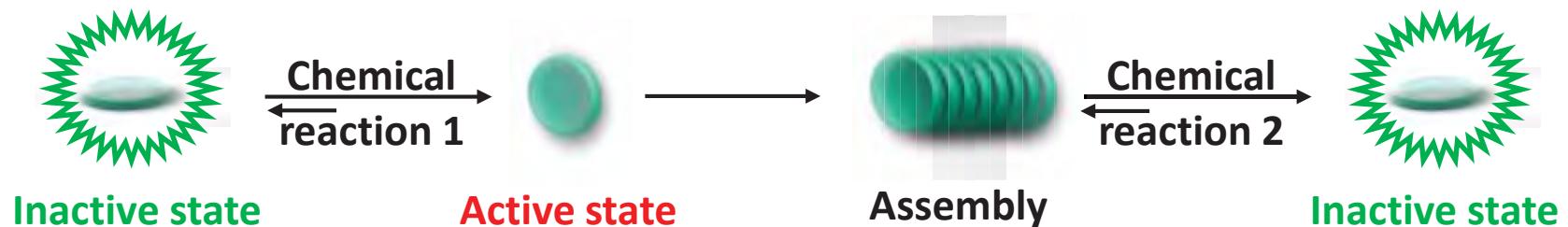
b) Living supramolecular polymerization



Sugiyasu, Takeuchi,
Nature Chemistry 2015
Nature Chemistry 2017

Aida
Science 2015

Inspiration from Biological Systems

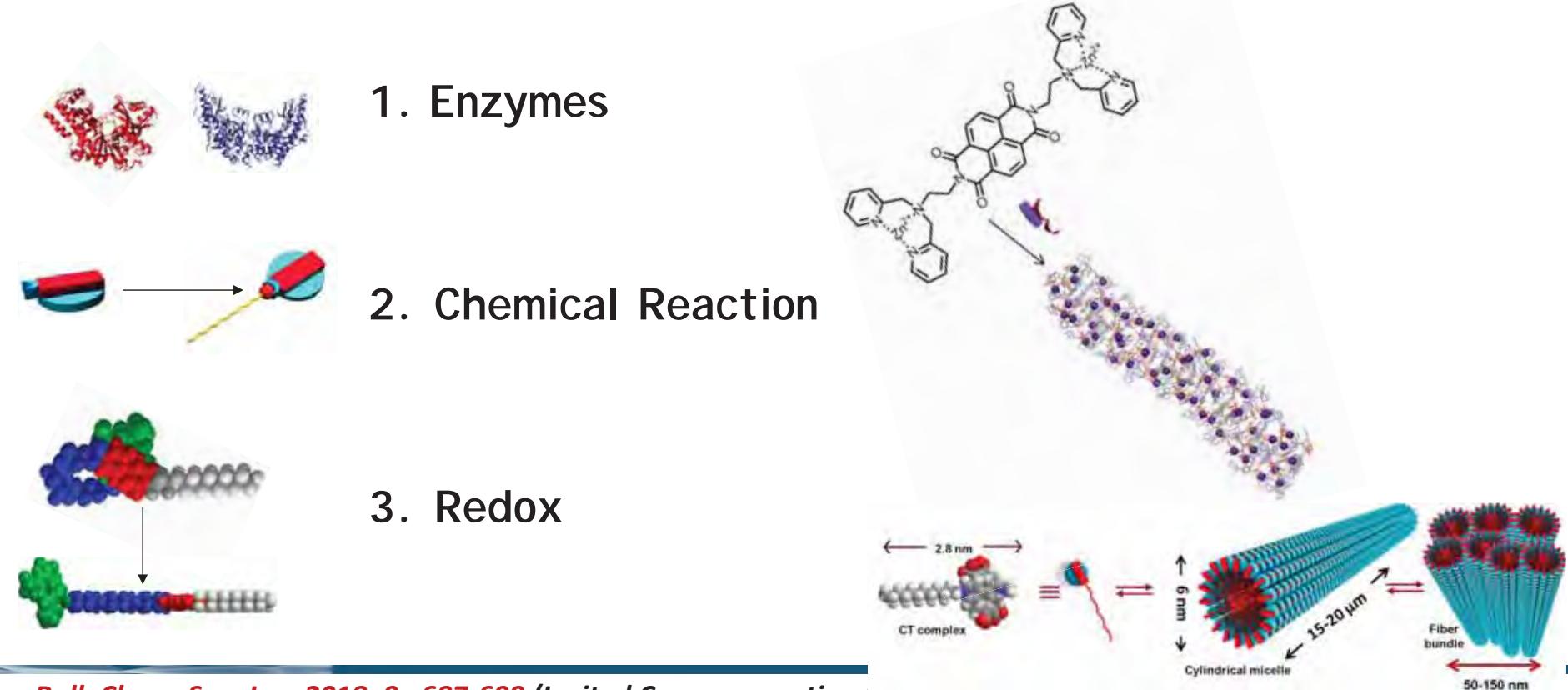


Inner life of a cell-youtube

youtube

**Biological Self assembly process undergo chemical fuel-driven
temporally controlled assembly**

Fuel-Driven Temporal Supramolecular Polymers



Bull. Chem. Soc. Jap. 2018, 9, 687-699 (Invited Commemorative Account)

Nature Communications 2014, 5, 5793 (Highlighted in Nature Chemistry, Nature India)

Angew. Chem. Int. Ed. 2017, 129, 1349 (Hot Article, Highlighted in Nature Nanotechnology)

Chem. Sci. 2017, 8, 6030 (Hot Article, Chemical Science Blog)

J. Am. Chem. Soc. 2017, 139, 16568 (Spotlight Article, Front Cover)

J. Am. Chem. Soc. 2017, 139, 13867

Nature Communications 2018, 9, 1295

Angew. Chem. Int. Ed. 2019 (Invited Review on 'Fuel-Driven, Non-equilibrium Supramolecular Materials', In submission)

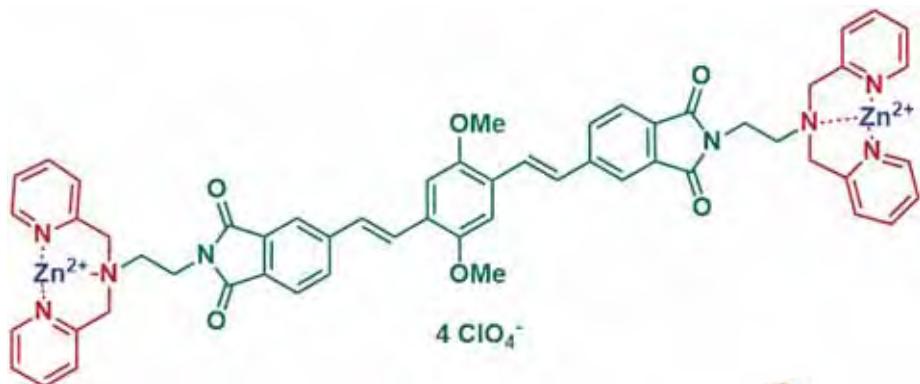
Nature Communications 2019, 10, 450

Nature Communications 2019 (Under revision)

Thermodynamically Stable Dormant States



Ananya Mishra



OPVDPA

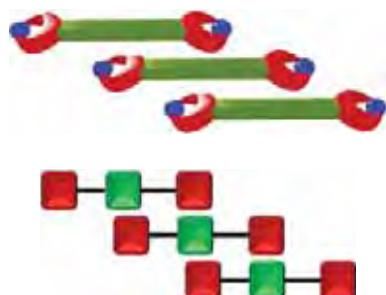


Donor

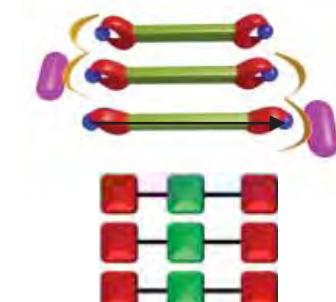
Acceptor



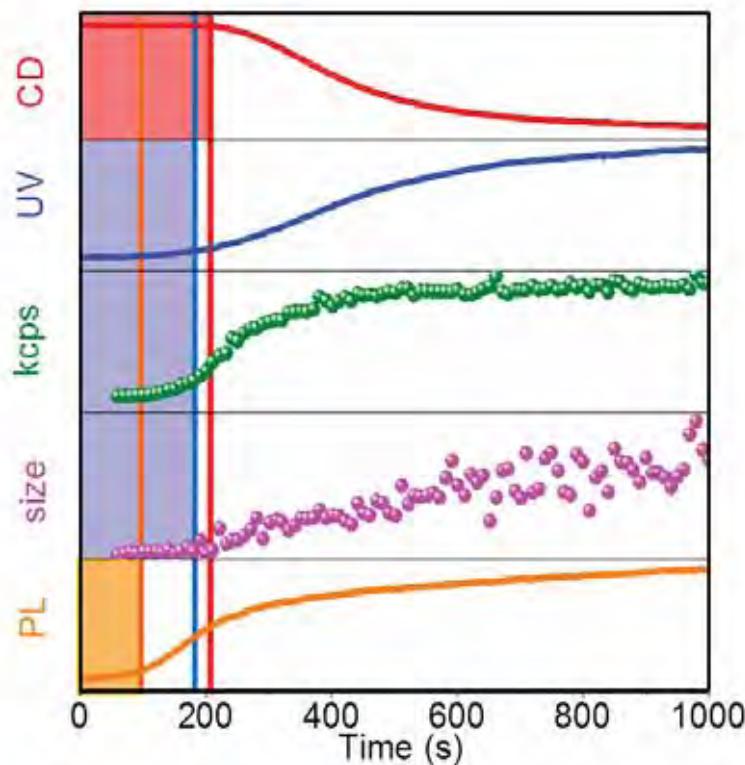
Acceptor



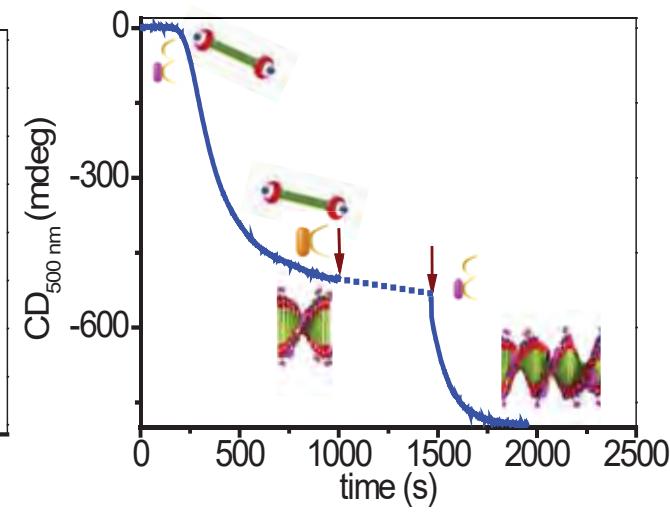
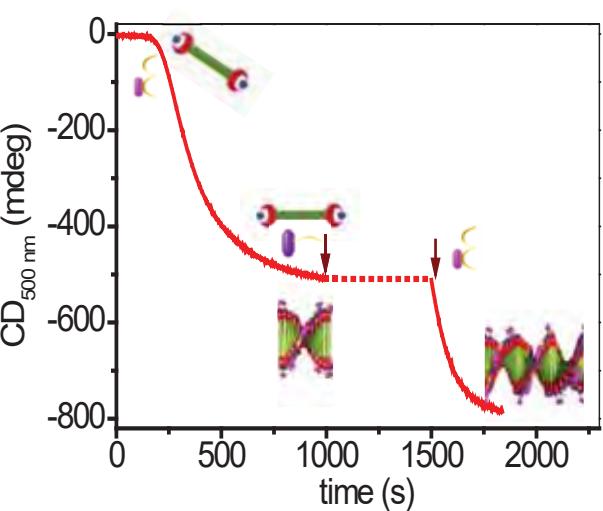
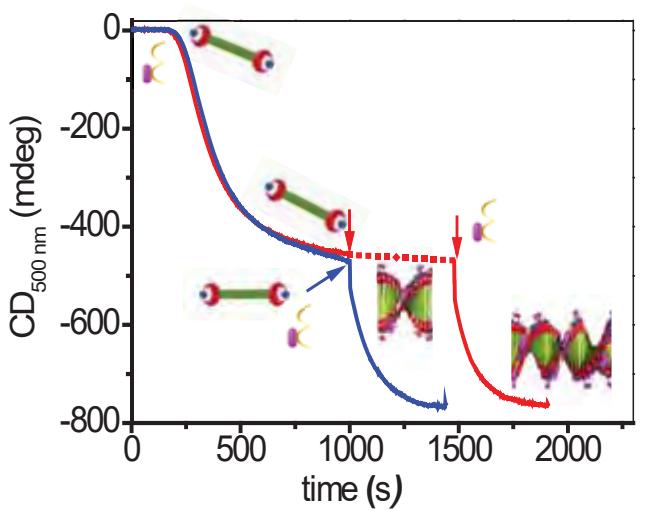
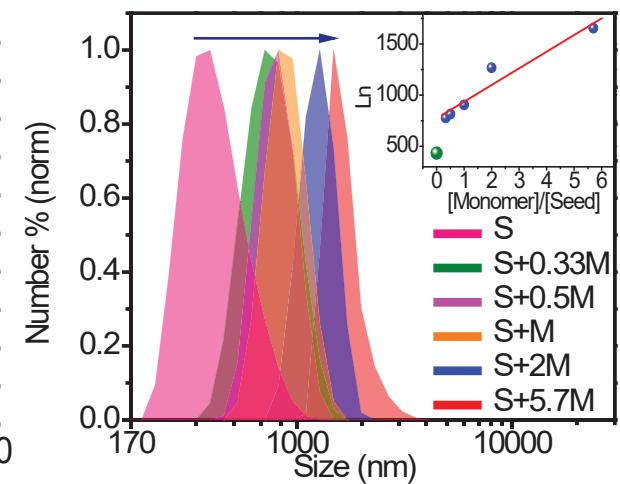
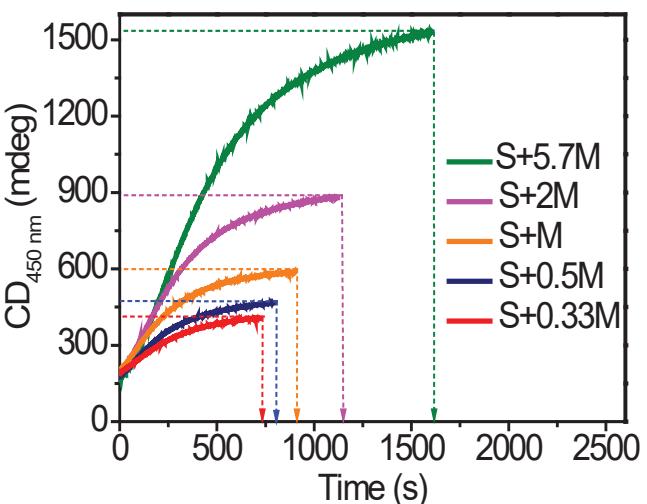
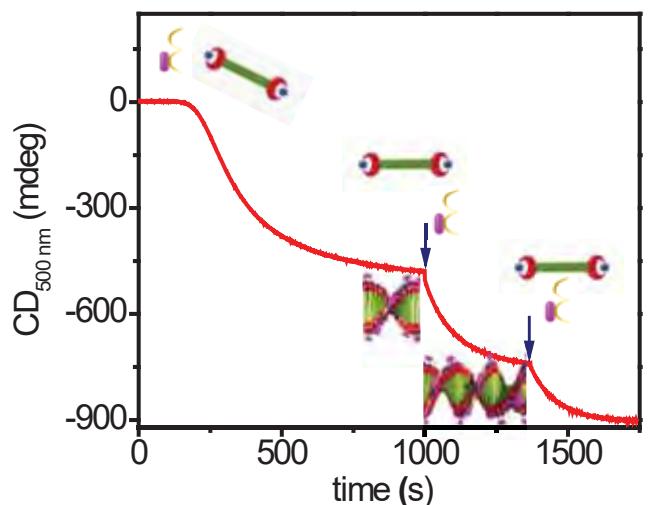
Inactive conformation



Active conformation

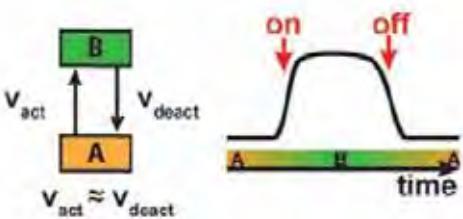


Fuel-Driven Co-operative, Seeded and Living !

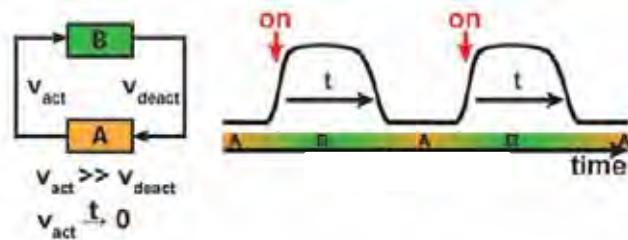


Bio-inspired Chemical Programming for Active Materials

Passive Materials



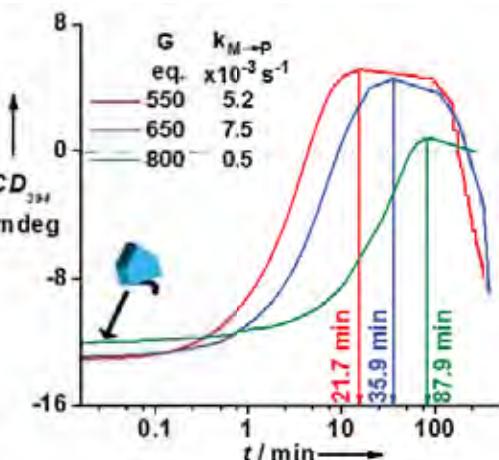
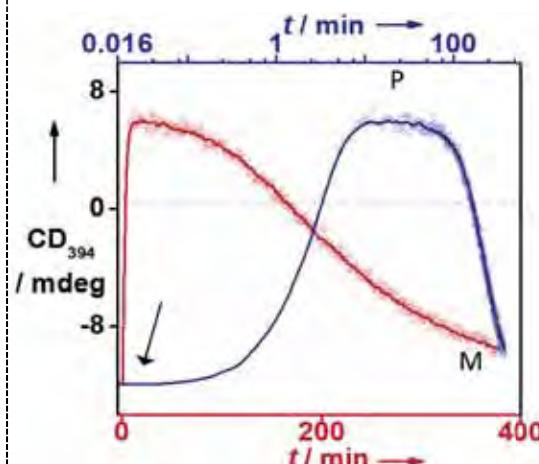
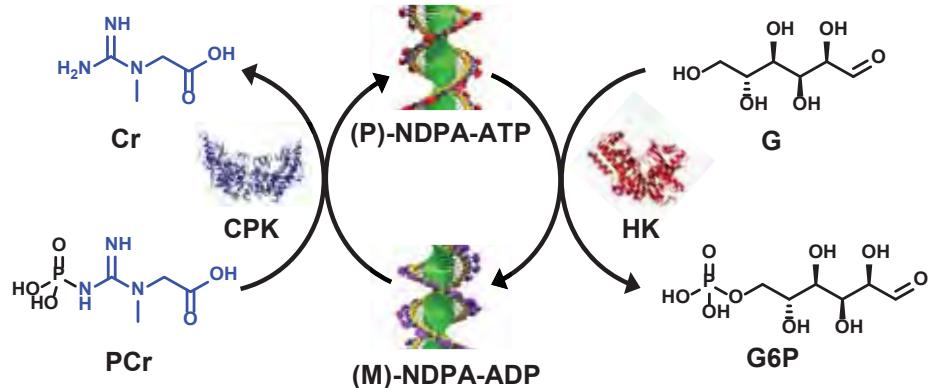
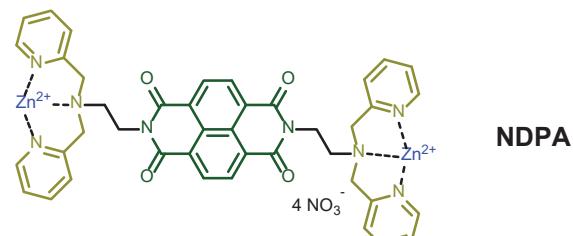
Transient/Active materials



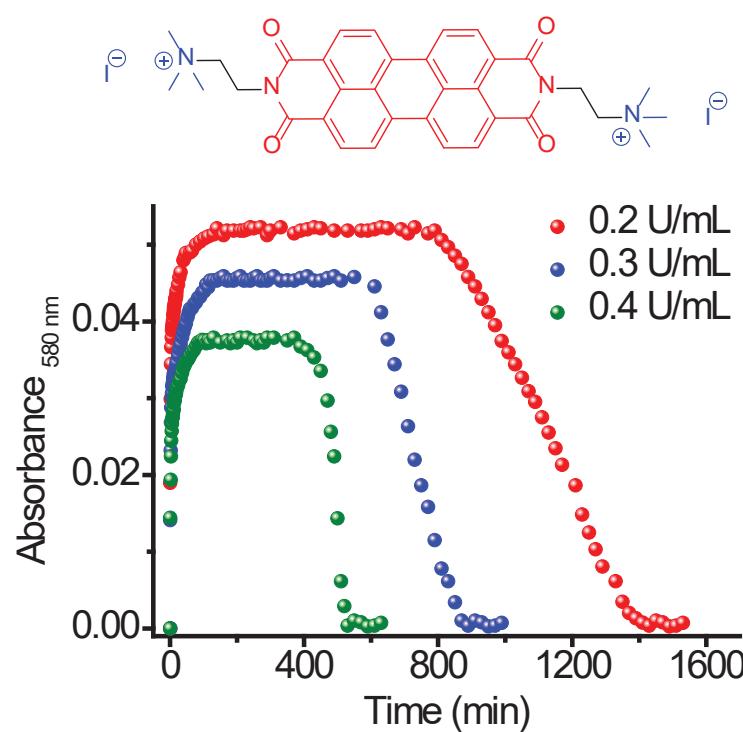
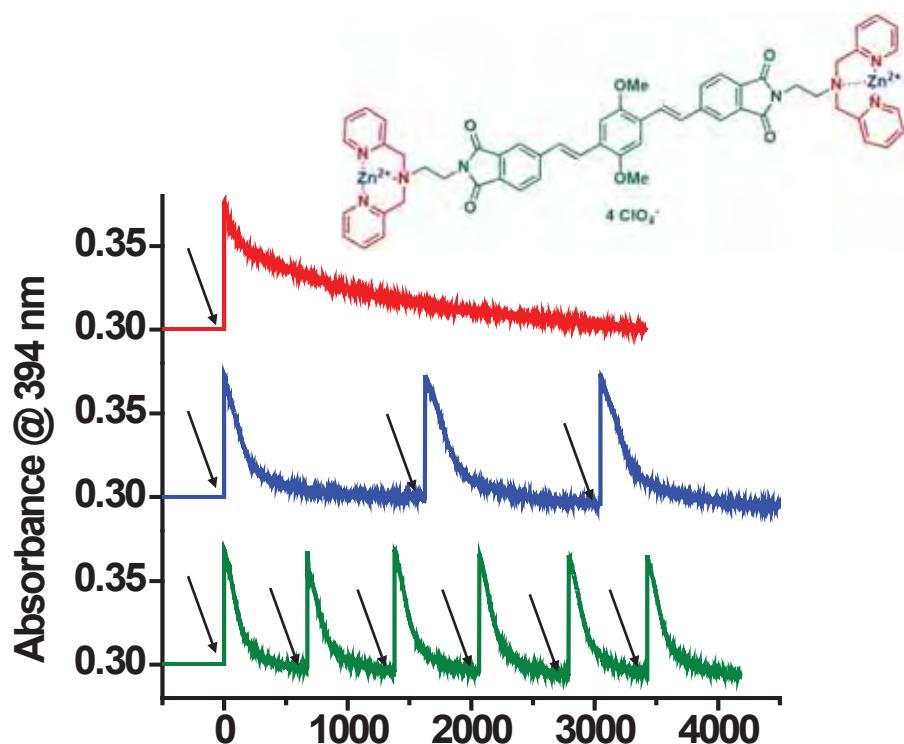
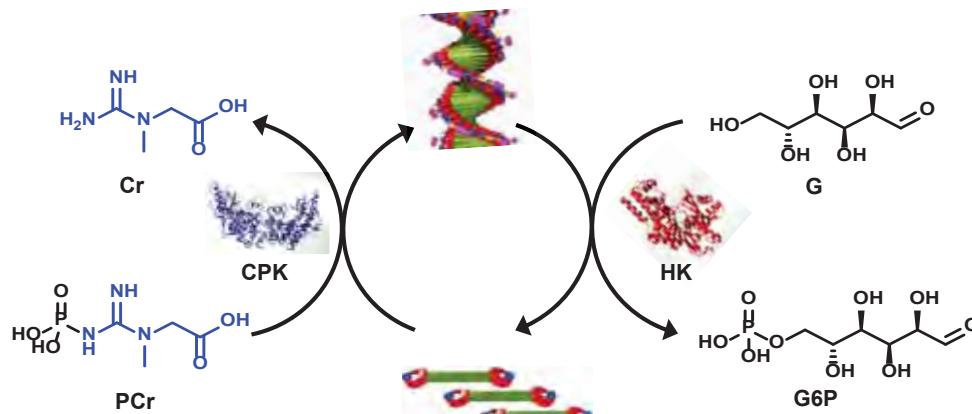
v_{act} = rate of activation (energy input)

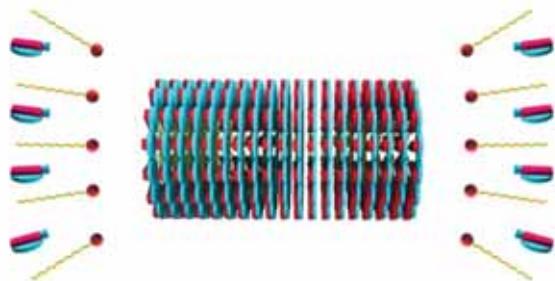
v_{deact} = rate of deactivation (energy dissipation)

Transient helicity

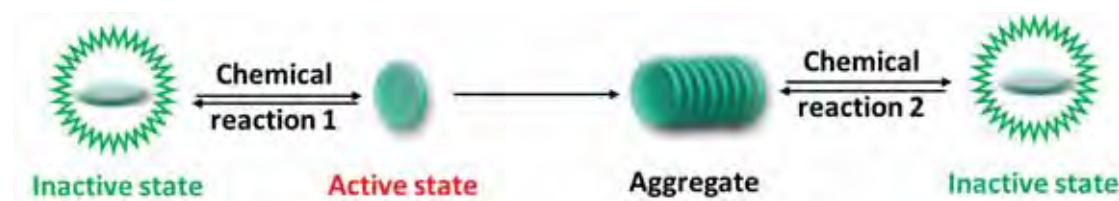


Transient Assemblies..

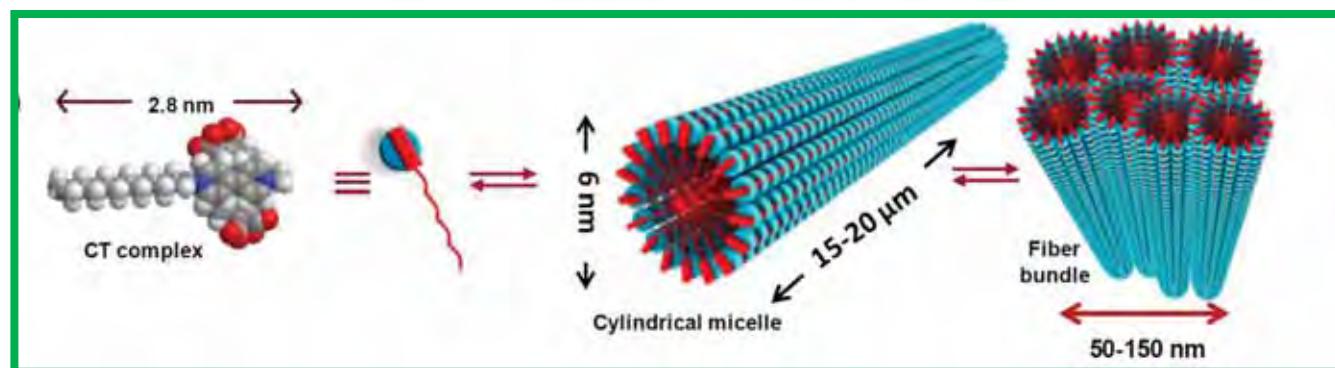
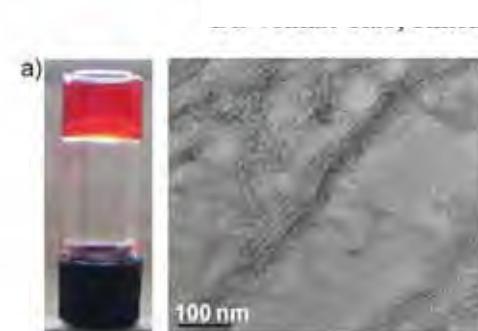
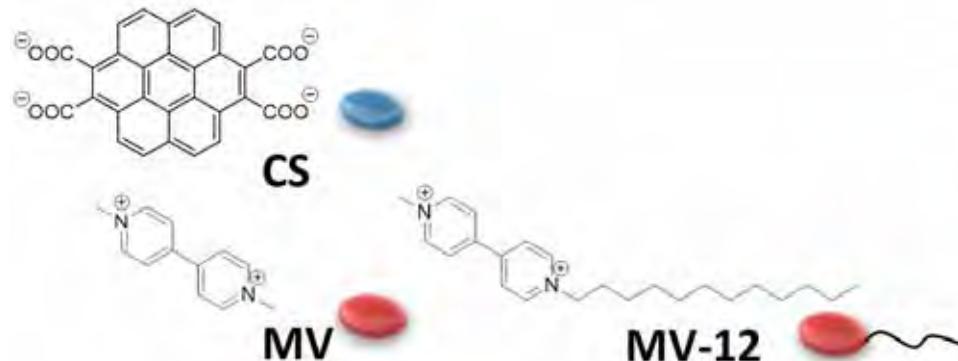




Chemical fuel driven assemblies...



Venkata Rao

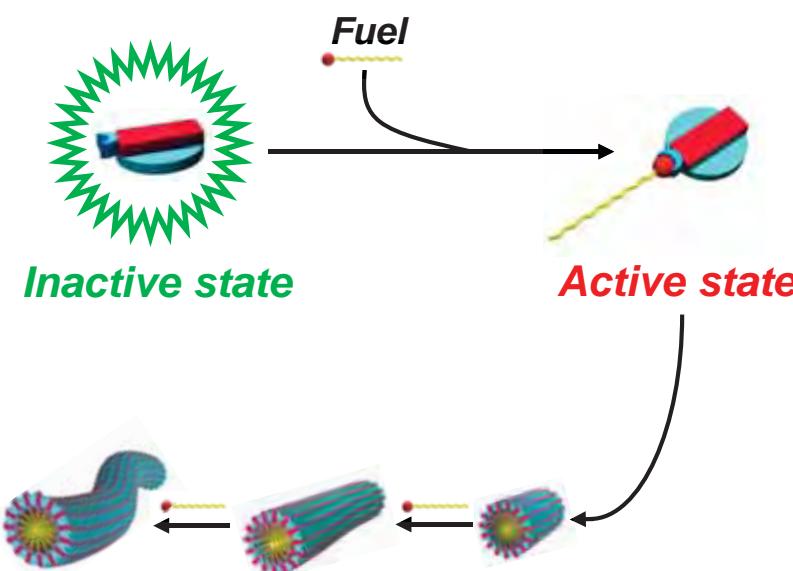


Reaction Coupled Growth of CT Systmes



Ankit Jain

Shikha

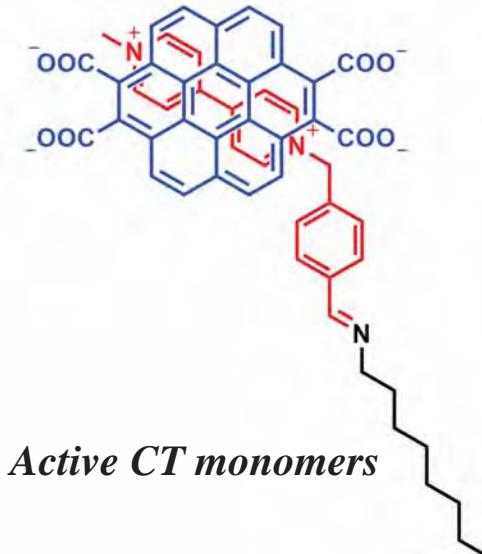
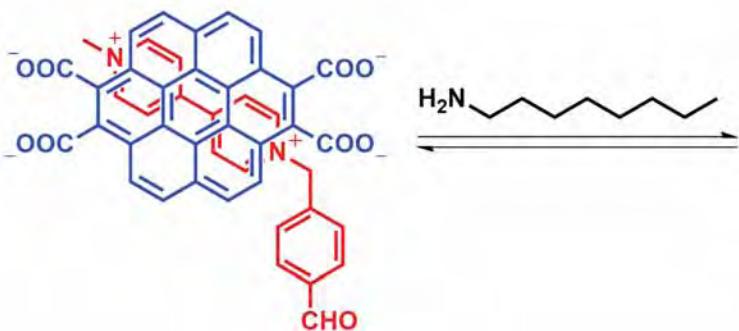


Kinetics of Chemical Reaction

Supramolecular Polymer

Rate of Growth

DP = Monomer to Seed ratio

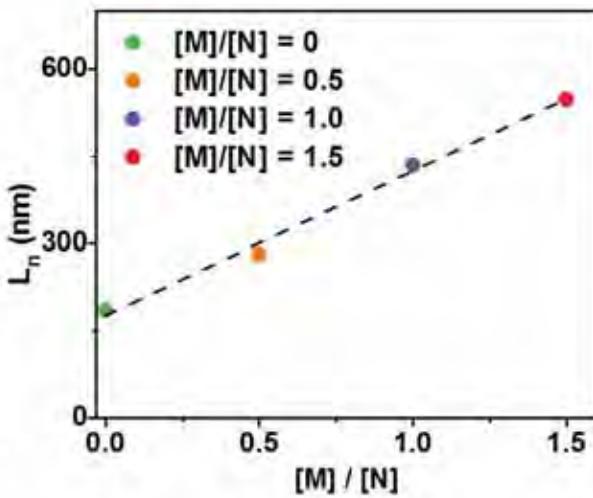
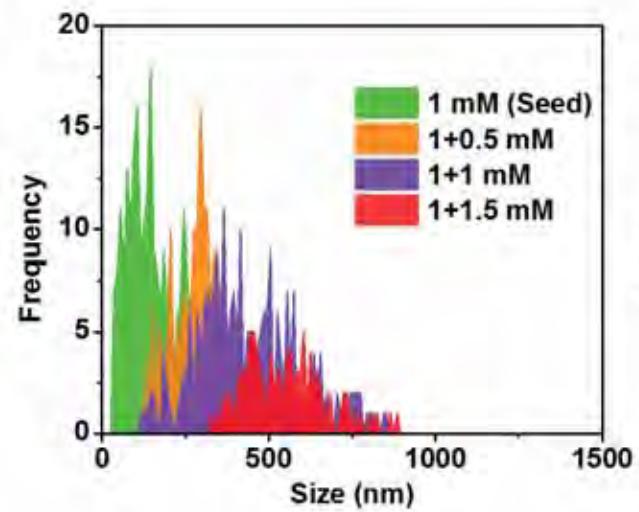
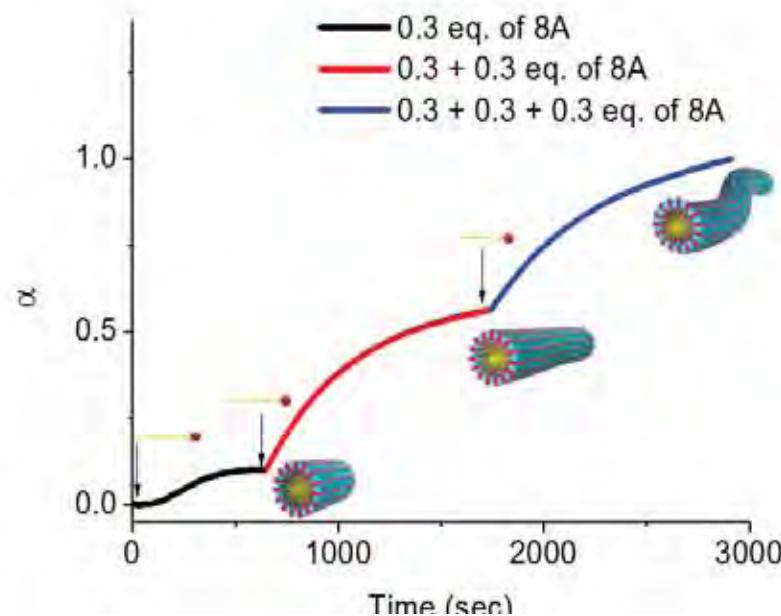
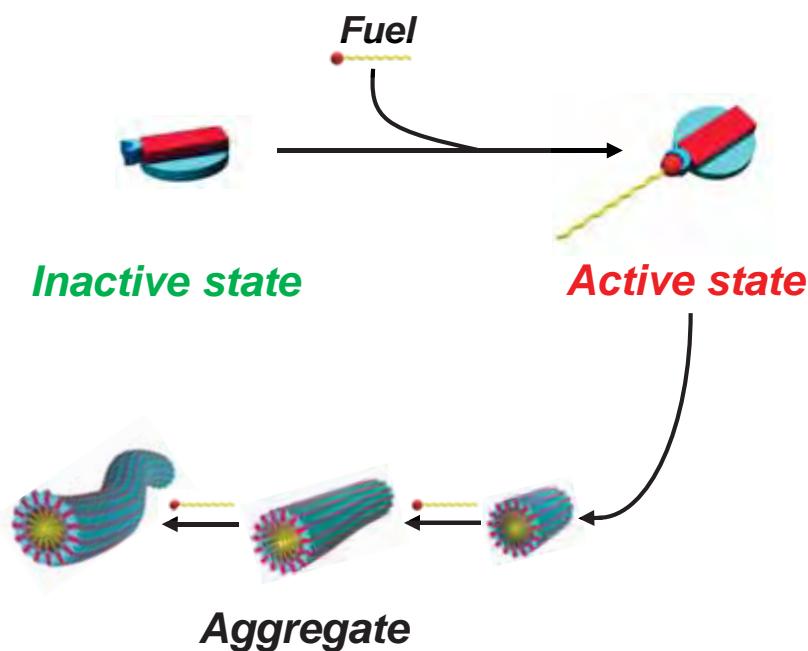


- Seeded
- DP = Monomer to Seed ratio
- | | | | |
|------|------------------|---|---|
| 3A | H ₂ N | — | — |
| 5A | H ₂ N | — | — |
| 6A | H ₂ N | — | — |
| 2E6A | H ₂ N | — | — |
| 8A | H ₂ N | — | — |
| 12A | H ₂ N | — | — |

Inactive CT monomer

Active CT monomers

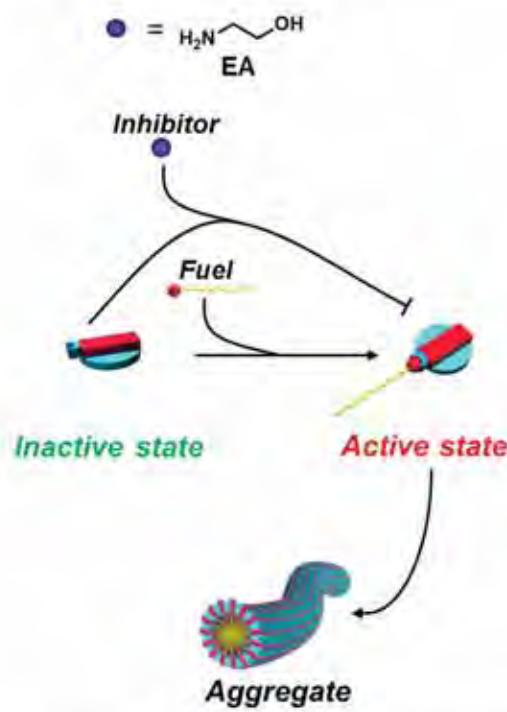
Reaction Driven Cooperative, Seeded and Living



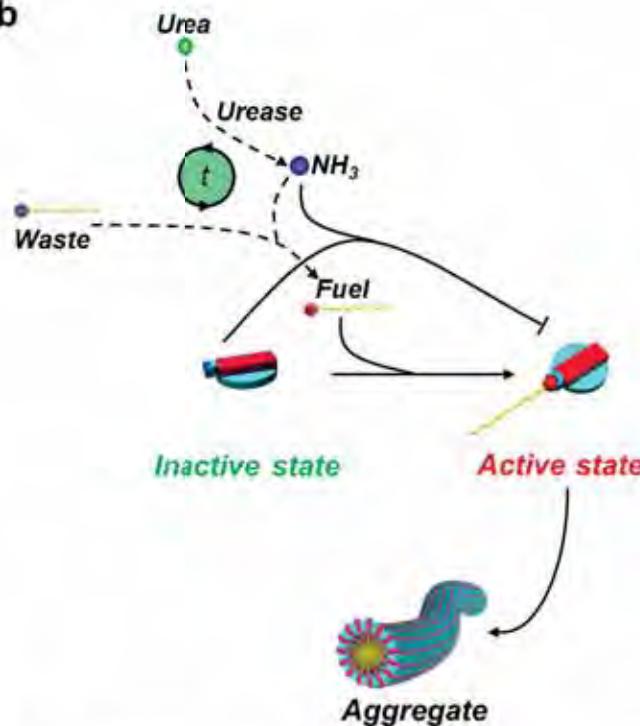
$[M] / [N]$	L_n	PDI (L_w / L_n)
0	186 nm	1.30
0.5	282 nm	1.20
1.0	435 nm	1.12
1.5	548 nm	1.10

Modulation of Nucleation and Growth

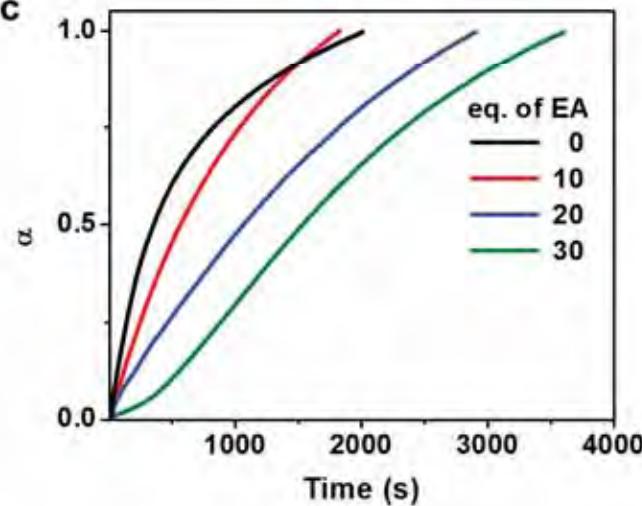
a



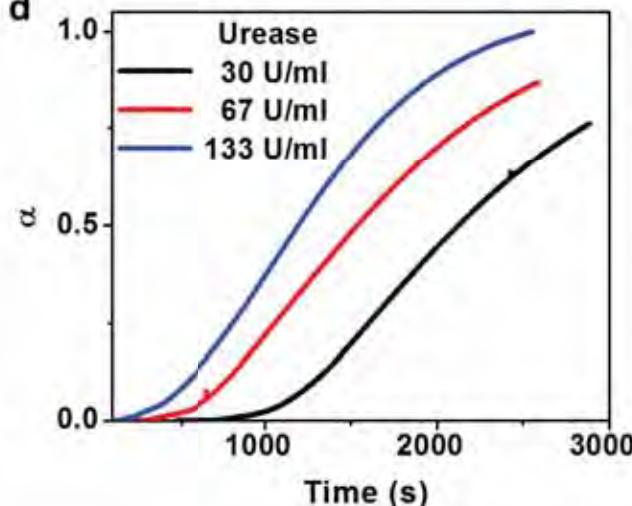
b



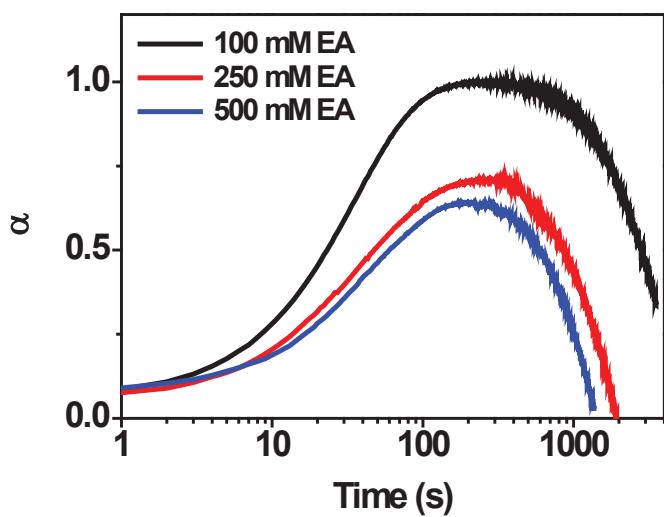
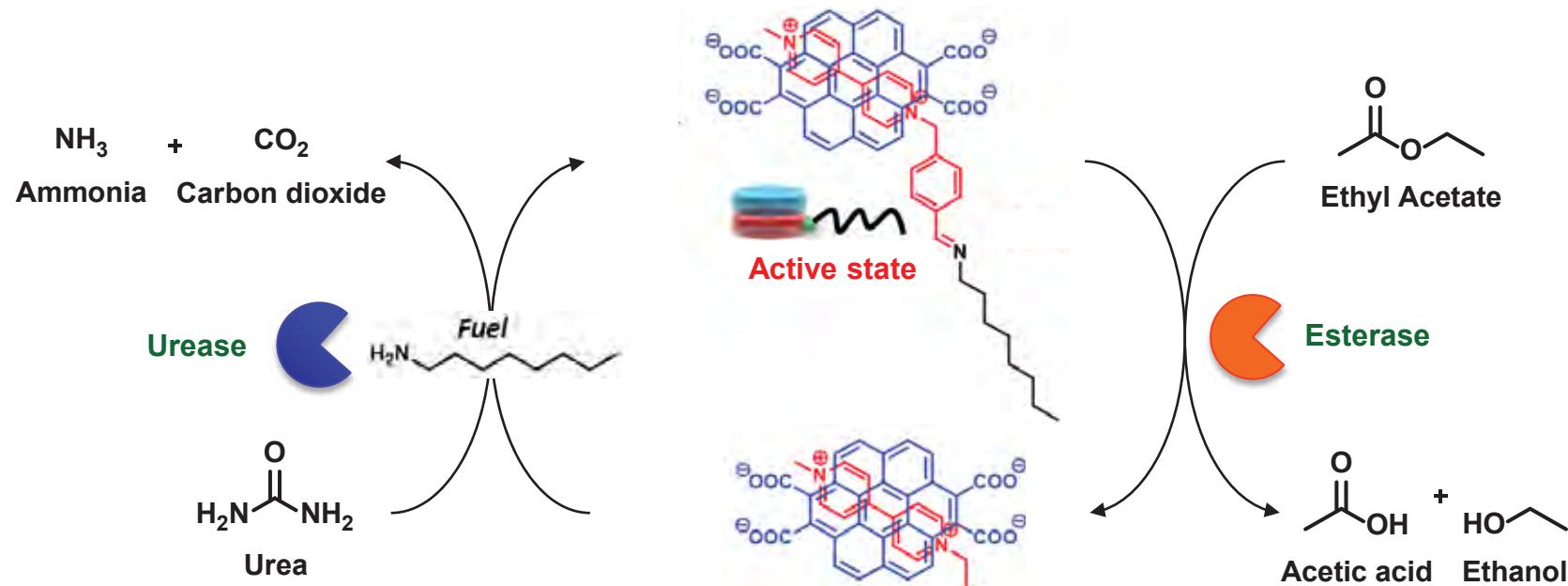
c



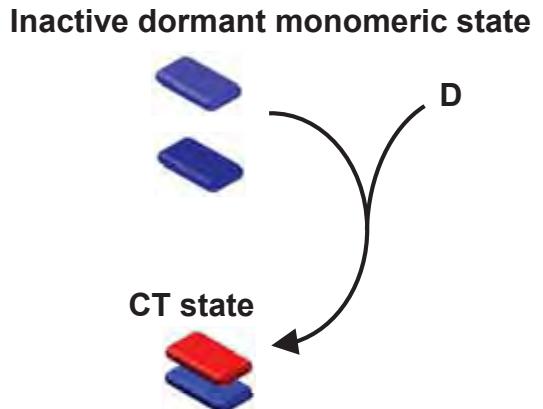
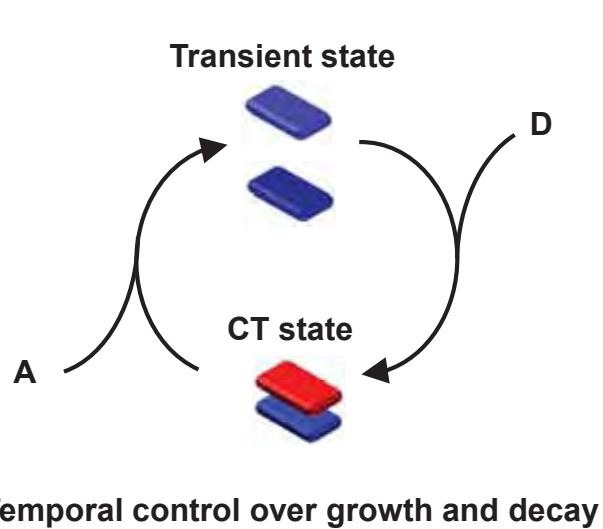
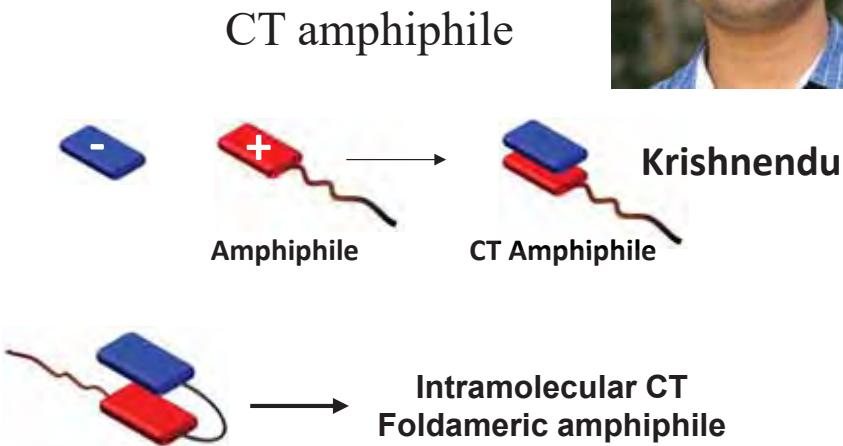
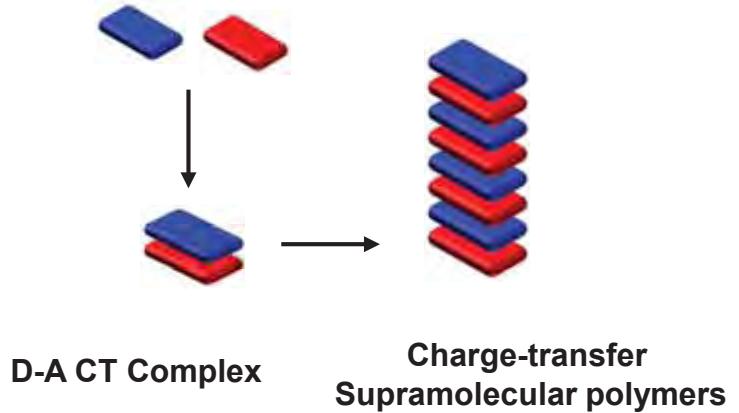
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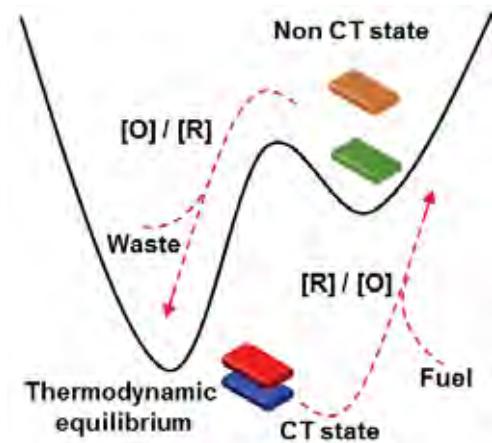
Temporally Modulated Supramolecular Polymers



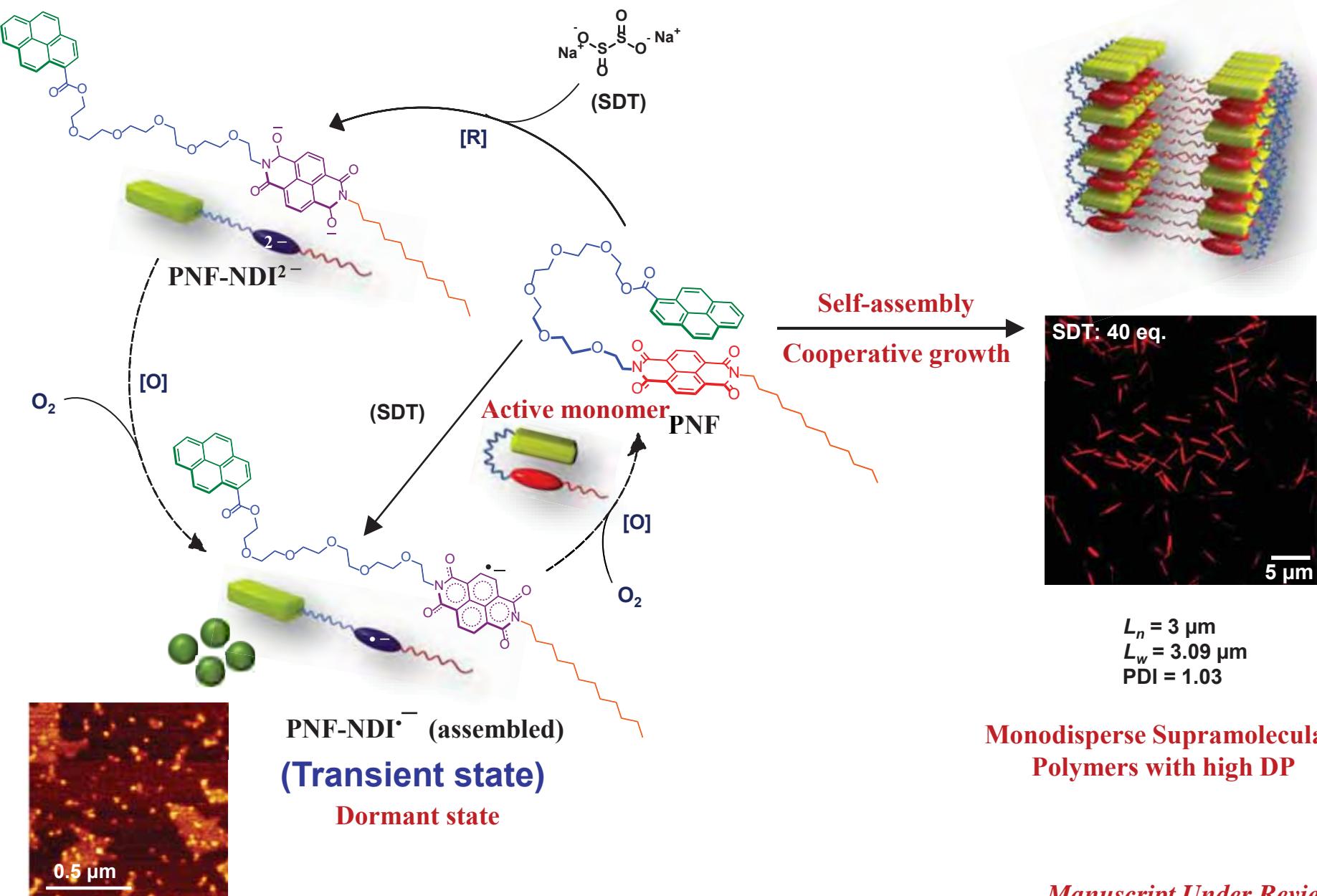
Redox Fueled Living and Transient Charge-Transfer Assemblies



Temporal control over the growth

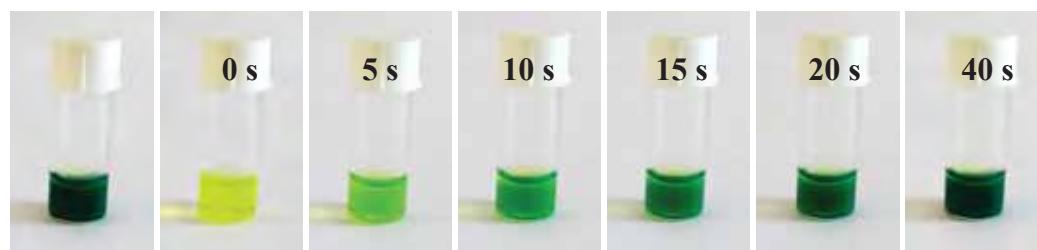
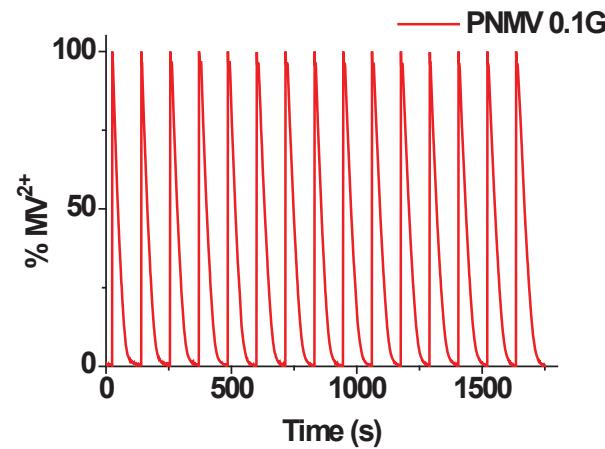
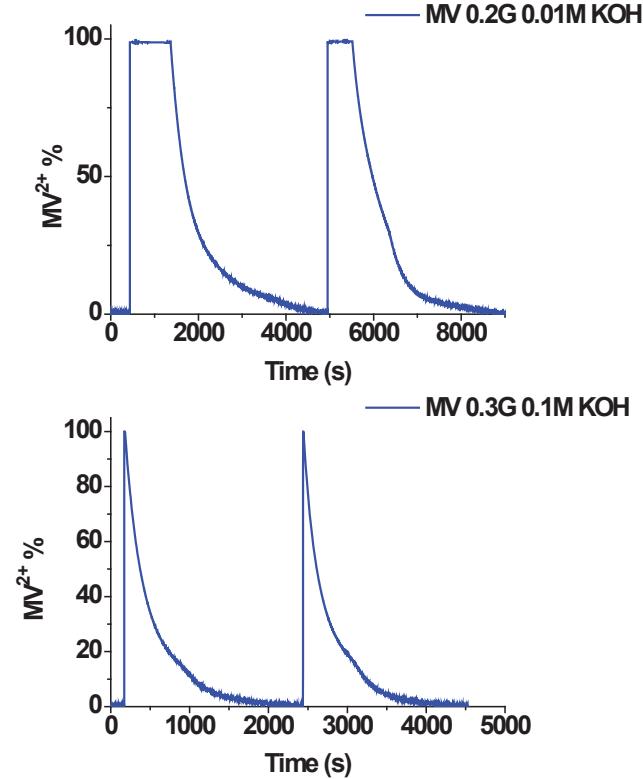
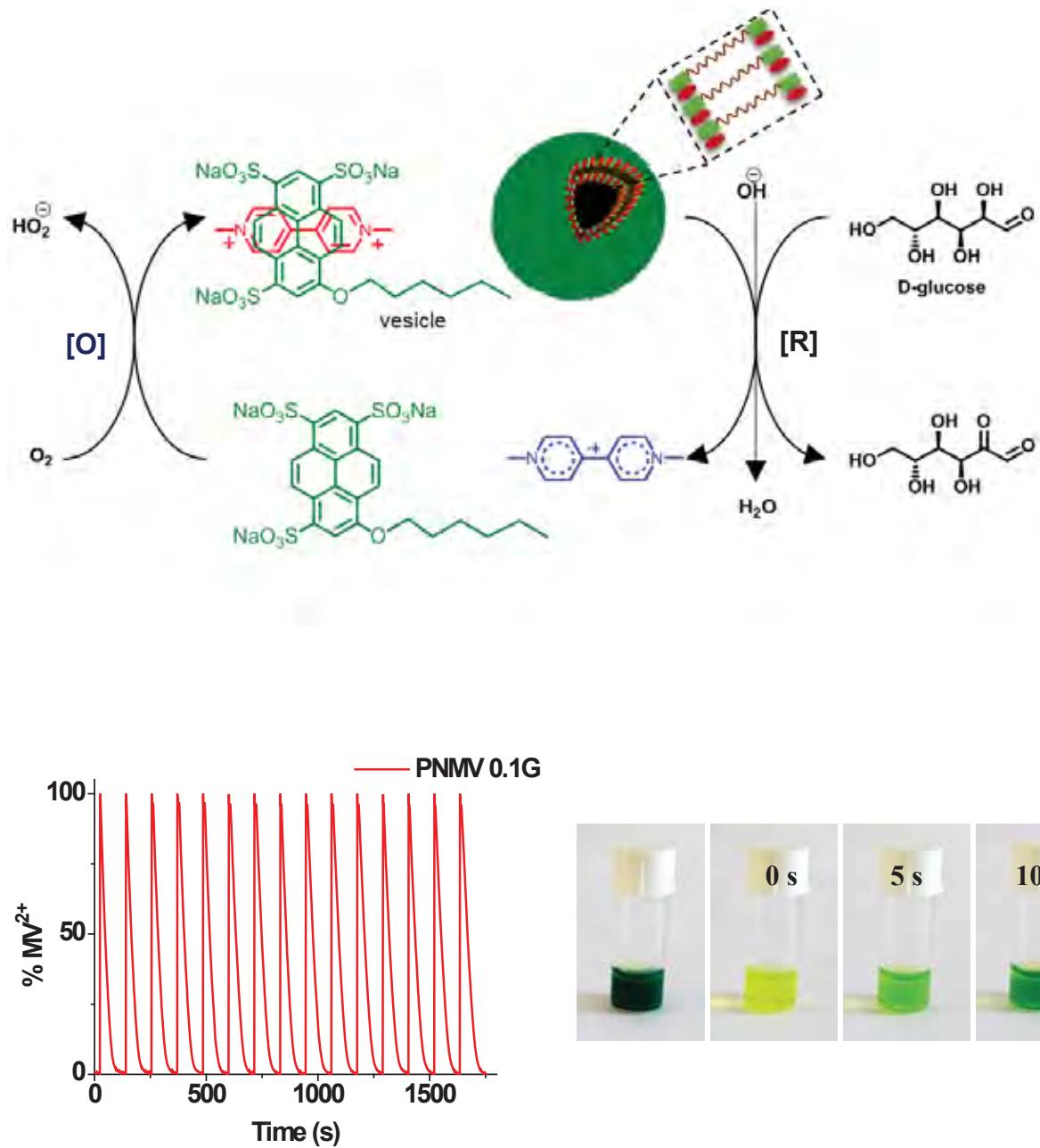


Redox Fueled Living and Transient Assembly

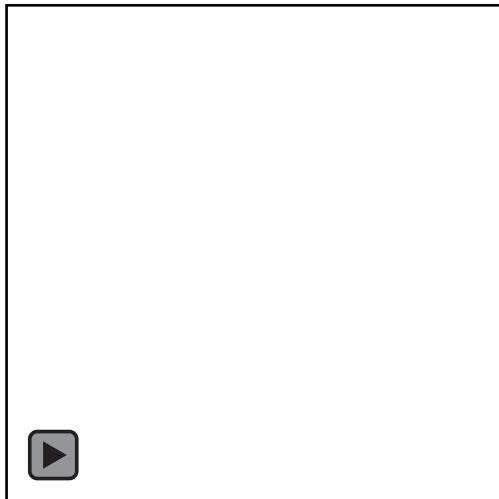
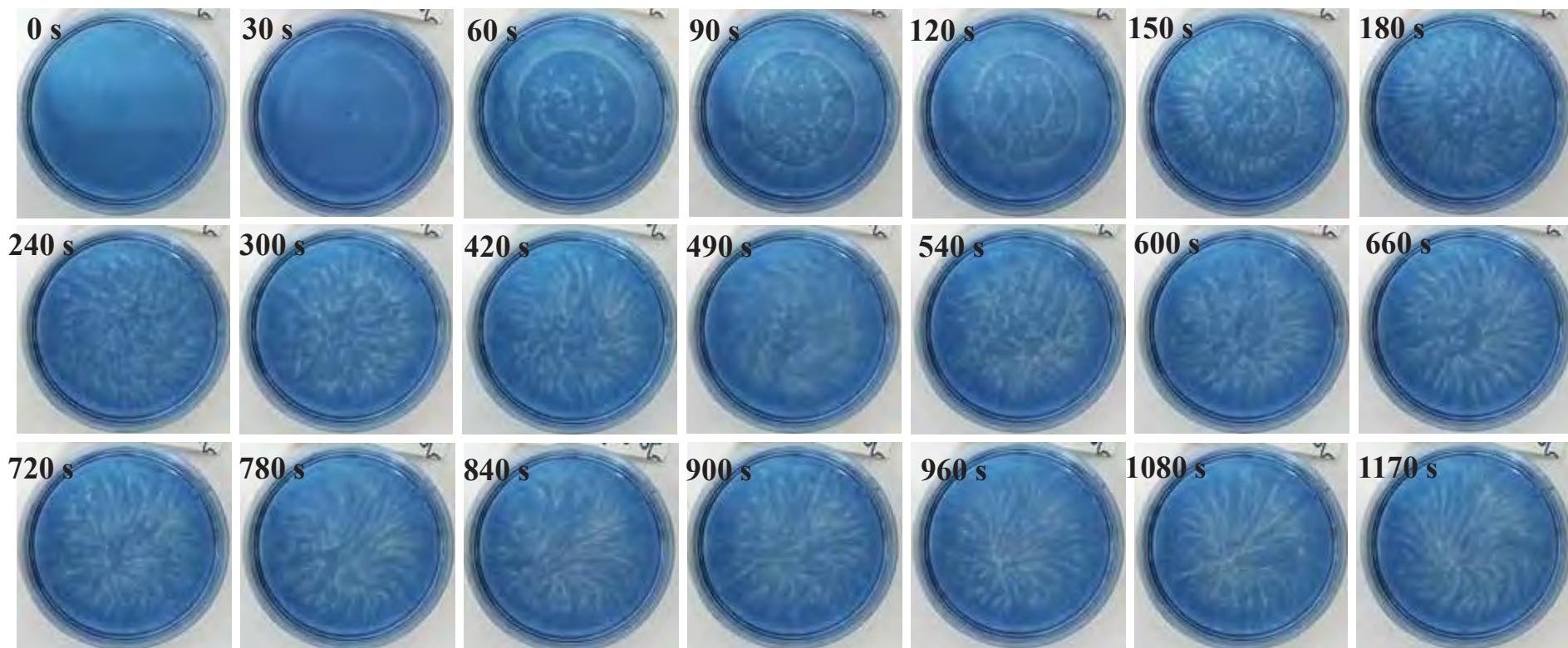


Monodisperse Supramolecular Polymers with high DP

Transient vesicles

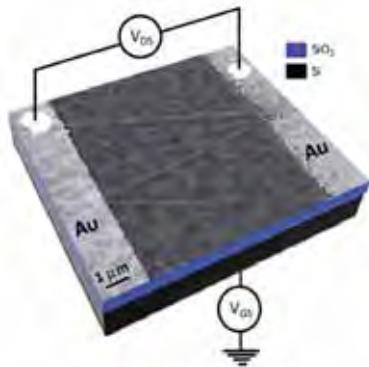


Non-equilibrium Turing Patterns



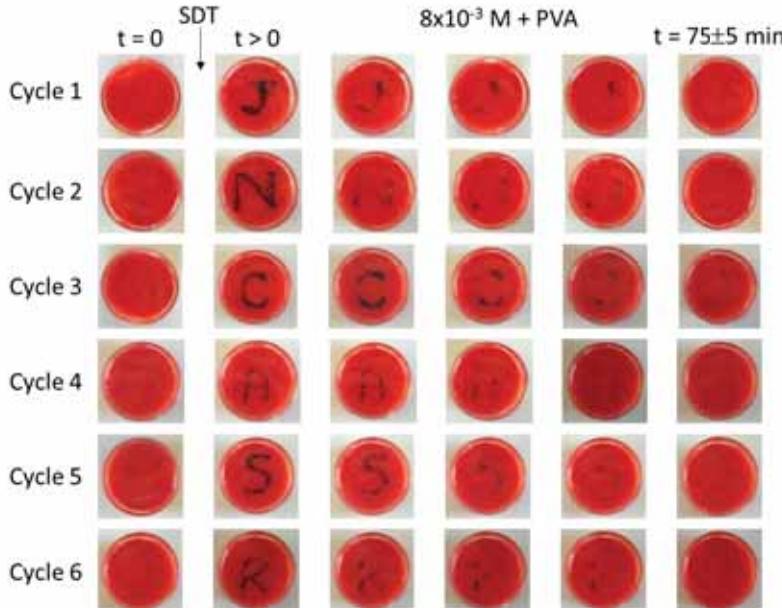
Ongoing...

Soft-Lithography

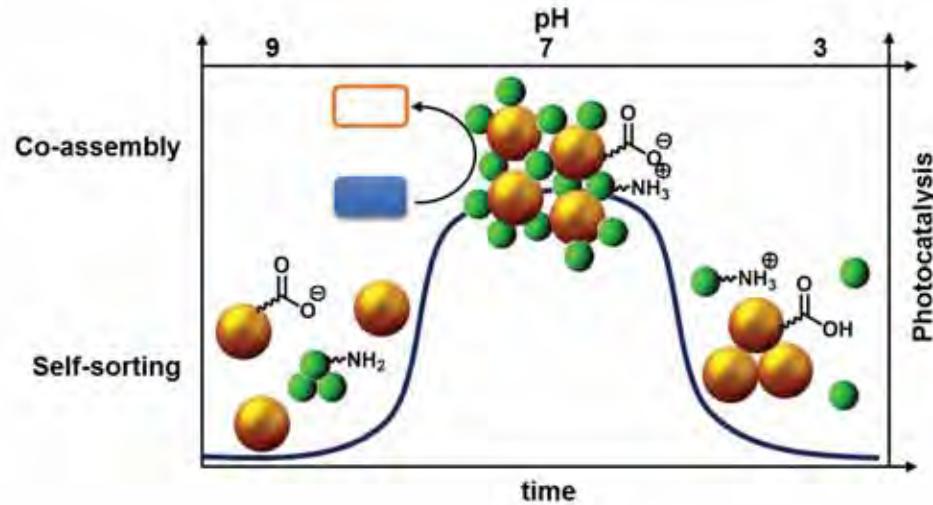


Transient semi-conducting circuits

Self-erasing Inks



Transient Catalysis



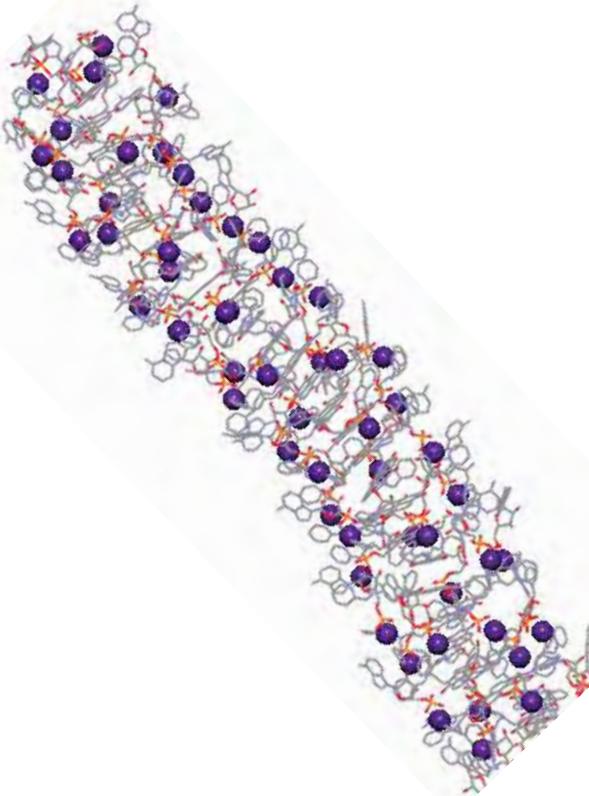
Transient or temporal Ion transport



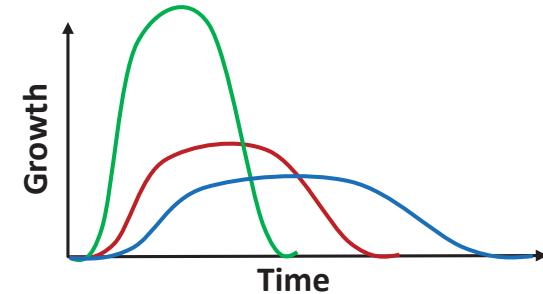
Transient Hydrogels, Transient Vesicles!

(Under Review)

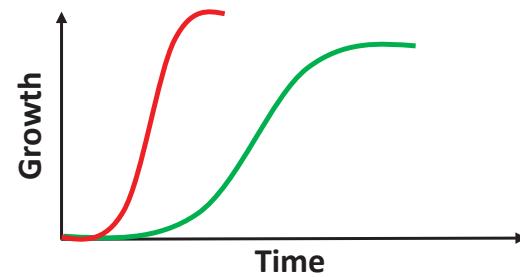
Temporally Modulated Supramolecular Polymers



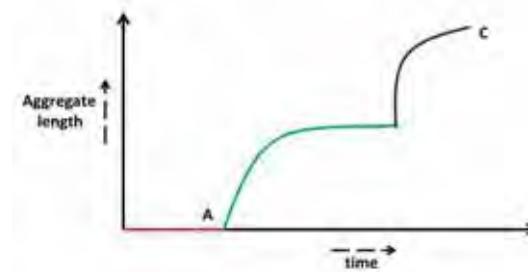
Active materials



Mono-disperse



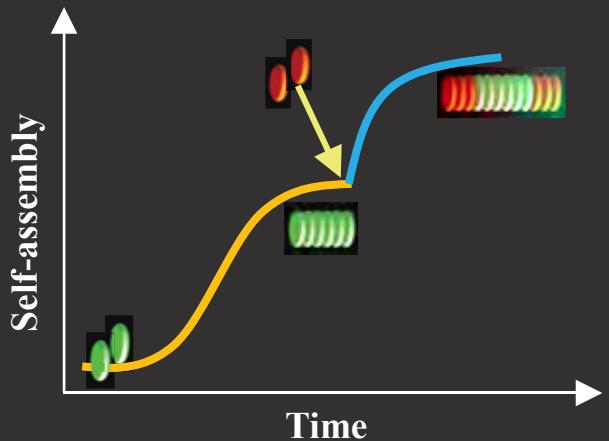
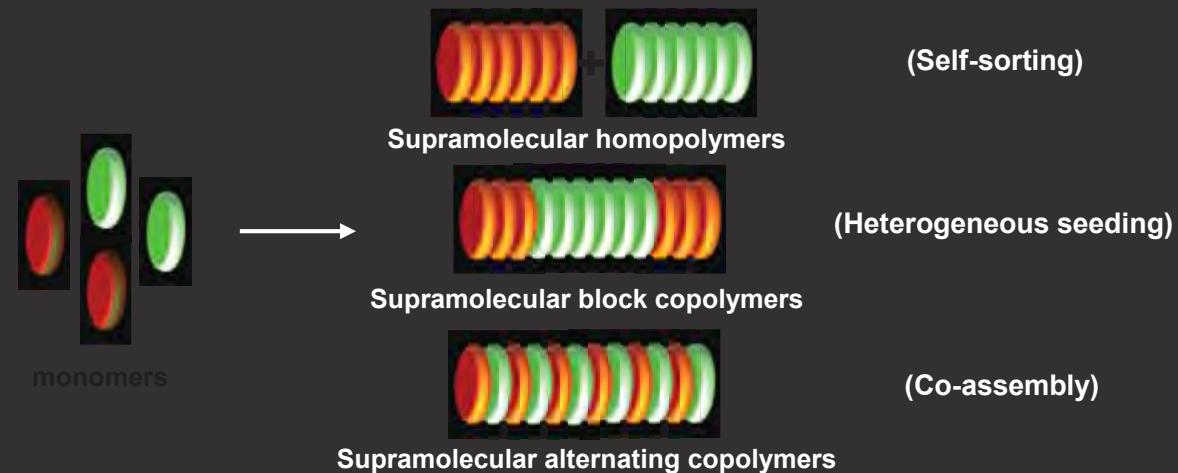
Multi-Component



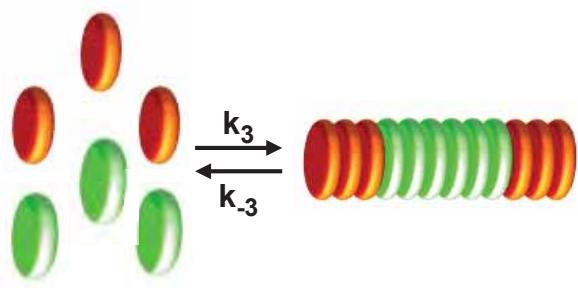
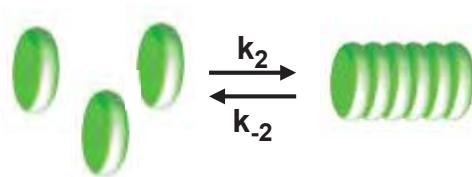
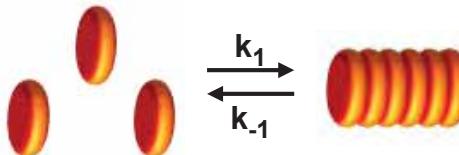
Multi-Component Supramolecular Polymerization



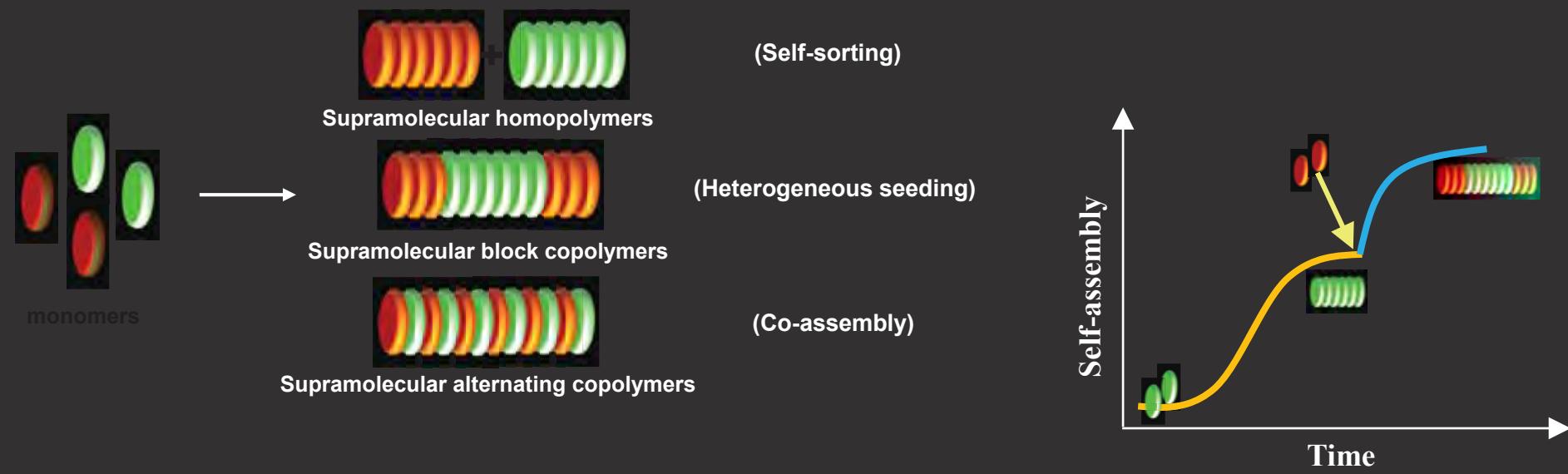
Aritra Shikha Kamna



Exchange dynamics, Structural Mismatch and Mechanism of Growth



How to Construct Supramolecular Block Co-Polymers?



Intermolecular interactions

Homorecognition



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Heterorecognition



Kinetic control



Blocks

Thermodynamic control



Alternate



>



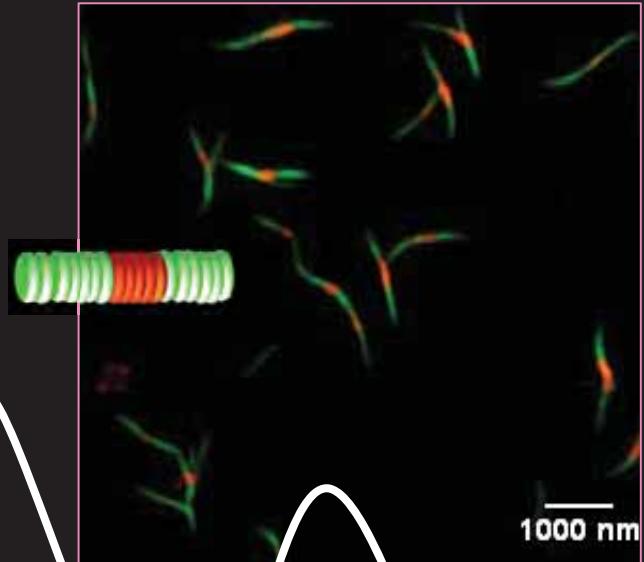
Blocks



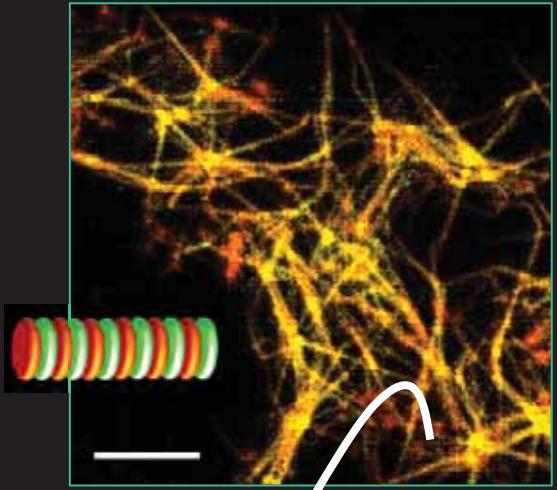
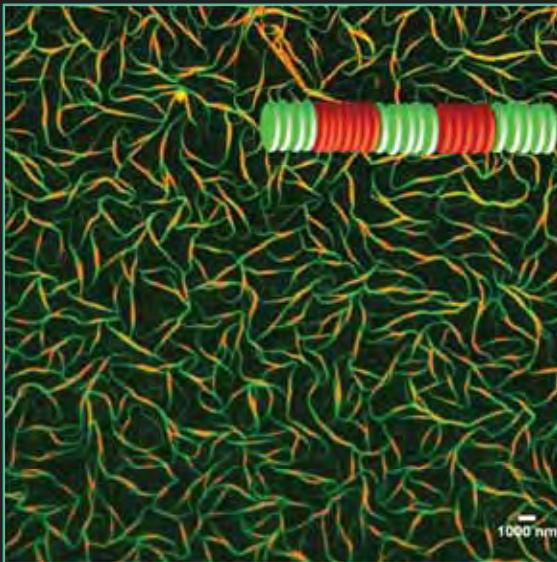
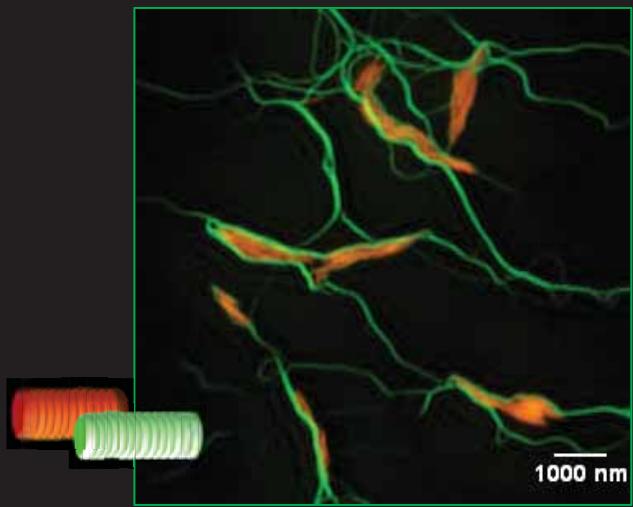
Blocks



G (Gibbs Free Energy)



Under progress





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MD Simulations

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