Title: Synchrony based evolution of various biological and artificial systems to understand complex computational aspects.

Funding Agency: Department of Science and Technology

Completion date: 12/03/2019

Project PI: Dr. Satyajit Sahu

Brief description: The natural computing power is enormous in comparison to the artificial computing powers because artificial computing has the structural limitations and processing bottlenecks. So, if a powerful computing machine has to be created then it must mimic natural systems. So, in this project we tried to follow natural computing system and tried to come up with an artificial system that can do similar kind of computation as that of natural system.

Schematics or Pictures:

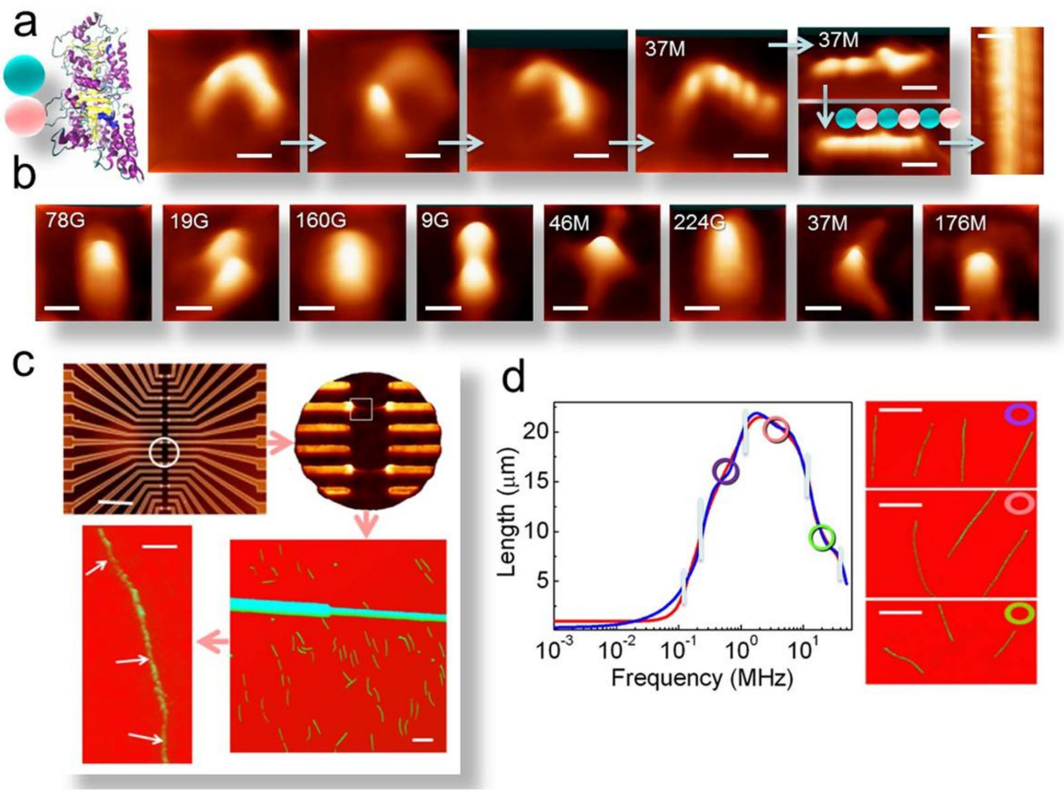

Figure. STM images of single tubulin self-assembly into protofilaments: (a). Tubulin molecule (left most). Series of STM images (2 V tip bias 10 pA current) of three protein molecules, they form a perfect linear assembly and stabilize. Scale bar for first four images 3.8 nm, for the last two images (one above another), scale bar is 5 nm. Protofilaments connected (extreme right), scale bar 8 nm. (b). STM images at

2.1 V tip bias 30 pA current, left to right frequencies are noted in Hz, M means mega 106 Hz, G means Giga 109 Hz, scale bar for all images 4 nm. (c). SEM image of a typical artificial cell environment (scale bar top left 1 mm). A circular region is expanded in its right, one electrode associated region is highlighted below (scale bar 4 mm), small hair like structures are microtubule like cylinders, one cylinder like structure is zoomed in its left (scale bar 150 nm). (d). Experimental (red) and theoretical (blue) average length of microtubules (standard deviation,200 nm) as a function of a.c. signal frequency (top left). AFM images of microtubules (right, top-to-bottom) grown at 500 kHz (scale bar is 7 mm), 5 MHz (scale bar is 5 mm) and 15 MHz (scale bar is 7 mm) on SiO_2/Si substrate.

Outcome: We have seen computing power of a group of synthetic molecules which mimiced the natural systems.

Publication if any:

1. Live visualizations of single isolated tubulin protein self-assembly via tunnelling current: effect of electromagnetic pumping during spontaneous growth of microtubule. S Sahu, S Ghosh, D Fujita, A Bandyopadhyay, **Nature Scientific Reports** 4, 7303, 2014
2. A complementary switching mechanism for organic memory devices to regulate the conductance of binary states. G Vyas, P Dagar, S Sahu, **Applied Physics Letters** 108 (23), 233301, 2016
3. Design, synthesis, and characterization of a Fe (ii)-polymer of a redox non-innocent, heteroatomic, polydentate Schiff's base ligand: negative differential resistance. D Oberoi, P Dagar, U Shankar, G Vyas, A Kumar, S Sahu, **New Journal of Chemistry** 42 (23), 19090-19100, 2018
4. Exponential increase in the on-off ratio of conductance in organic memory devices by controlling the surface morphology of the devices. G Vyas, P Dagar, S Sahu, **Applied Physics A** 124 (5), 369, 2018
5. Bidirectional multiple negative differential resistance (BM-NDR): An interplay between interface resistance and redox reaction, P Dagar, J Bera, G Vyas, S Sahu, **Organic Electronics** 71, 303-311, 2019
6. Molecular Memory Switching Device Based on a Tetranuclear Organotin Sulphide Cage [(RSnIV)4(μ-S)6]·2CHCl3·4H2O (R= 2-(phenylazo)phenyl): Synthesis, Structure, DFT Studies and Memristive Behavior, A. Mishra, A. Betal, N. Pal, R. Kumar, S. Sahu*, R. Metre*, ACS **Applied Electronic Materials**, 2, 1, 200-209, 2020