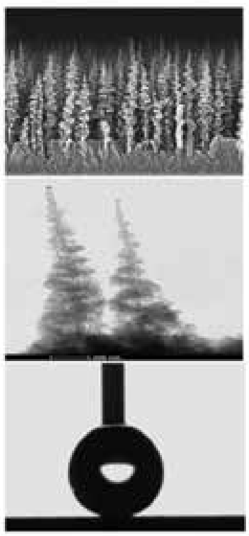
DIVISION OF

Physical and Mathematical Sciences

RESEARCH SNAPSHOTS 2018



G MOHAN RAO (IAP)

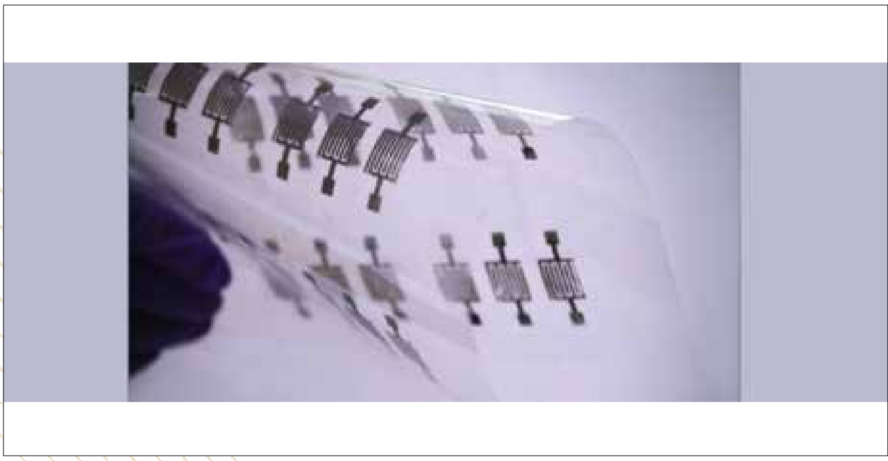
Novel tree like carbon nanostructures are grown by using ECR plasma CVD process with Hydrogen and acetylene in 1:3 ratio on a nickel coated silicon substrate. It consists of a central multiwall carbon nanotube with branches of crystalline carbon. The dimensions of the central spine and branches could be controlled by process parameter control. These structures are superhydrophobic, with a water contact angle of 1650. This material, which can be grown in any type of substrate in one step with super-hydrophobic as well as non-sticking properties with ideal Cassie mode of wetting, is a new direction in the field of super-hydrophobic nanostructures with two level roughness.

Reference: M. Ghosh, G. Mohan Rao , Carbon 133 (2018) 239-248

SANJIV SAMBANDAN (IAP)

Open circuit failure resistant interconnect is a key technology that would enable reliable flexible electronic circuits. Using a dispersion of conductive particles in an insulating fluid, researchers discuss the physics and engineering behind self-healing interconnects where repair is automatically triggered upon the occurrence of an open fault. Heals having metallic conductivity and nearly plastic stretchability are demonstrated. This work promises high speed, self-healing and stretchable interconnects thereby improving system reliability.

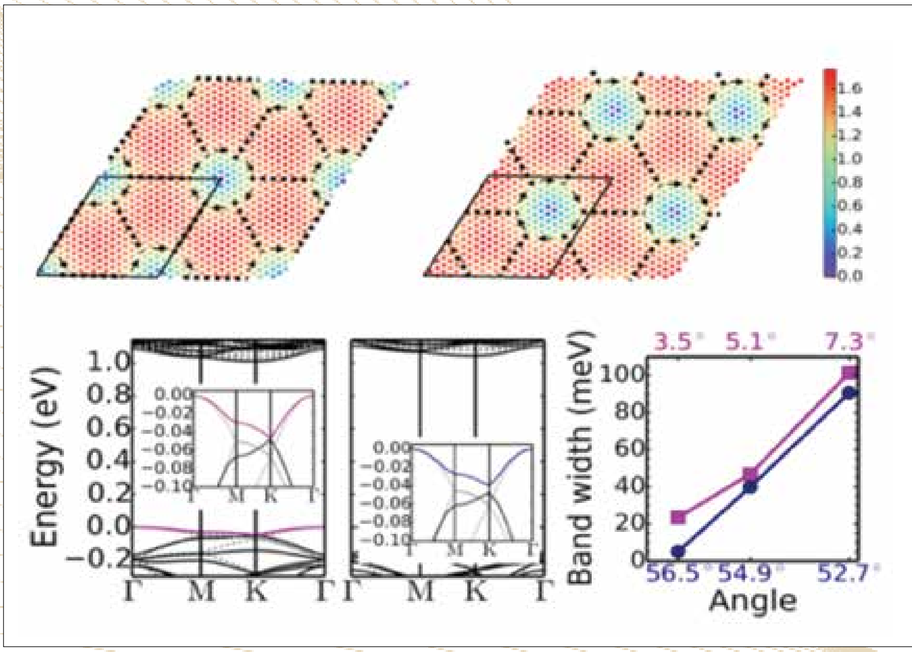
Reference: Amit Kumar, Virendra Parab, Arindan Handu, Li Ding, Pushkaraj Joshi, Chen Jiang, and Sanjiv Sambandan, Self-healing Interconnects with Nearly Plastic Stretching of Repairs, Phys. Rev. Applied 11, 014057 (2019)



ABHA MISRA (IAP)

Microsupercapacitors (MSC) store energy with higher power density than batteries. Reducing MSC size effectively without losing efficiency is a major challenge. A simple spray deposition technique is developed, whereby MSCs can be printed on any substrate. These MSCs can be recharged with higher frequency than usual batteries and have longer life, with possible applications in flexible electronic displays.

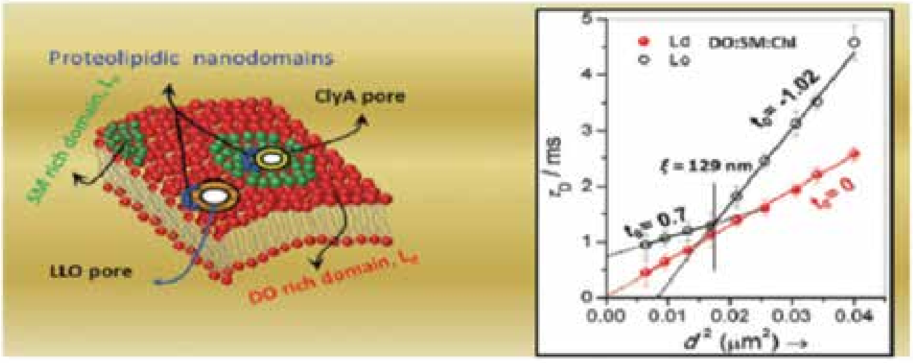
Reference: Flexible Array of Microsupercapacitor for Additive Energy Storage Performance Over a Large Area, http://iap.iisc.ac.in/~abha/



MANISH JAIN (PHY)

Ultraflatbands in twisted bilayers of two-dimensional materials have potential to host strong correlations, including the Mott-insulating phase at half-filling of the band. Using first principles density functional theory calculations, we show the emergence of ultraflatbands at the valence band edge in twisted bilayer MoS_2, a prototypical transition metal dichalcogenide. The moiré pattern also undergoes a structural transformation, leading to the formation of shear-strain solitons at stacking domain boundaries.

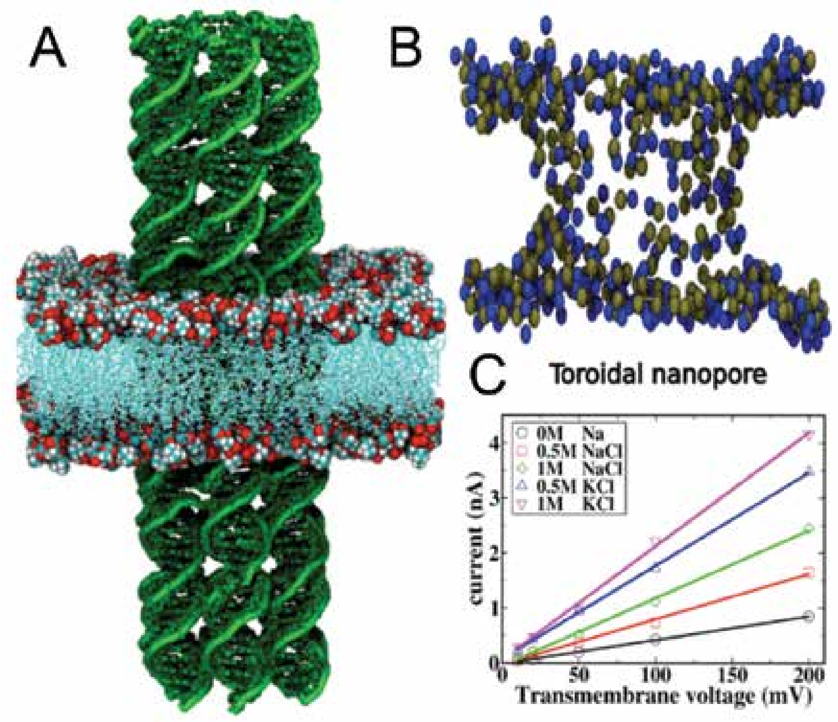
Reference: Mit H. Naik and Manish Jain, Phys. Rev. Lett. 121, 266401 (2018)



JAYDEEP KUMAR BASU (PHY)

We have reported the first direct determination of the size of these nanoscale regions in model raft-forming biomembranes using super-resolution stimulated emission depletion nanoscopy coupled with fluorescence correlation spectroscopy. The methodology establishes a new nano-biotechnological protocol which could be useful in preventing their cytotoxic effects.

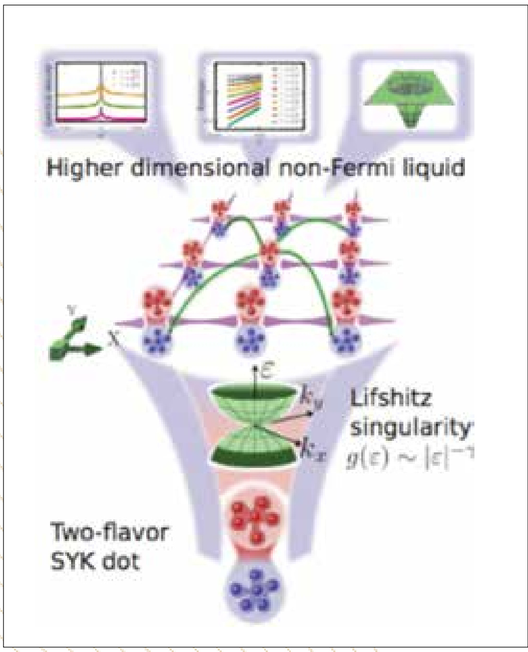
Reference: Nirod Kumar Sarangi and Jaydeep K Basu, Pathways for creation and annihilation of nanoscale biomembrane domains reveal alpha and beta-toxin nanopore formation processes, Phys. Chem. Chem. Phys. 20, 29116, 2018.



PRABAL K. MAITI (PHY)

State-of-the-art DNA nanotechnology was used to mimic the function of naturally occurring transmembrane biological nanopore. Using the analysis of several atomistic MD simulations in explicit solution, a novel mechanism was proposed to account for the stability of self-assembled DNA nanopore protruding into the lipid bilayer membrane (A). The atoms of lipid headgroups rearrange themselves into a toroidal shape around the DNA nanopore (B). The DNA-based transmembrane ion-channel demonstrates Ohmic characteristics for different ionic conditions (C) when subjected to a constant electric filed simulation.

Reference: H. Joshi and P.K. Maiti, Nucleic Acid Research, 46 (5), 2234-2242, 2018.



SUMILAN BANERJEE (PHY)

Some of the most interesting phenomena in condensed matter occur in high-temperature superconductors and heavy fermions, arising from a parent non-Fermi-liquid background. These often elude a clear theoretical description. Here, the authors develop a model that provides a route to describe non-Fermi liquids realized in condensed matter systems.

Reference: Arijit Haldar, Sumilan Banerjee, and Vijay B. Shenoy (2018), Higher-dimensional Sachdev-Ye-Kitaev non-Fermi liquids at Lifshitz transitions, Phys. Rev. B 97, 241106(R)