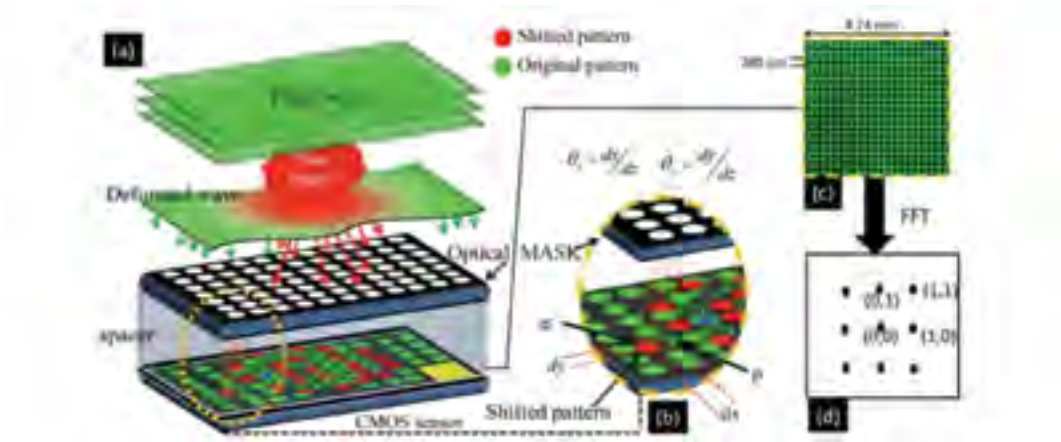
Research Snapshots 2018-19

S N Omkar (AE)

This drone surveillance system has been mainly developed to identify violent activities by individuals in large public areas. The system does so by first spotting each human in the image frame. Next, the body posture of each human is estimated which is then used to make a determination if two people are involved in violent activity.



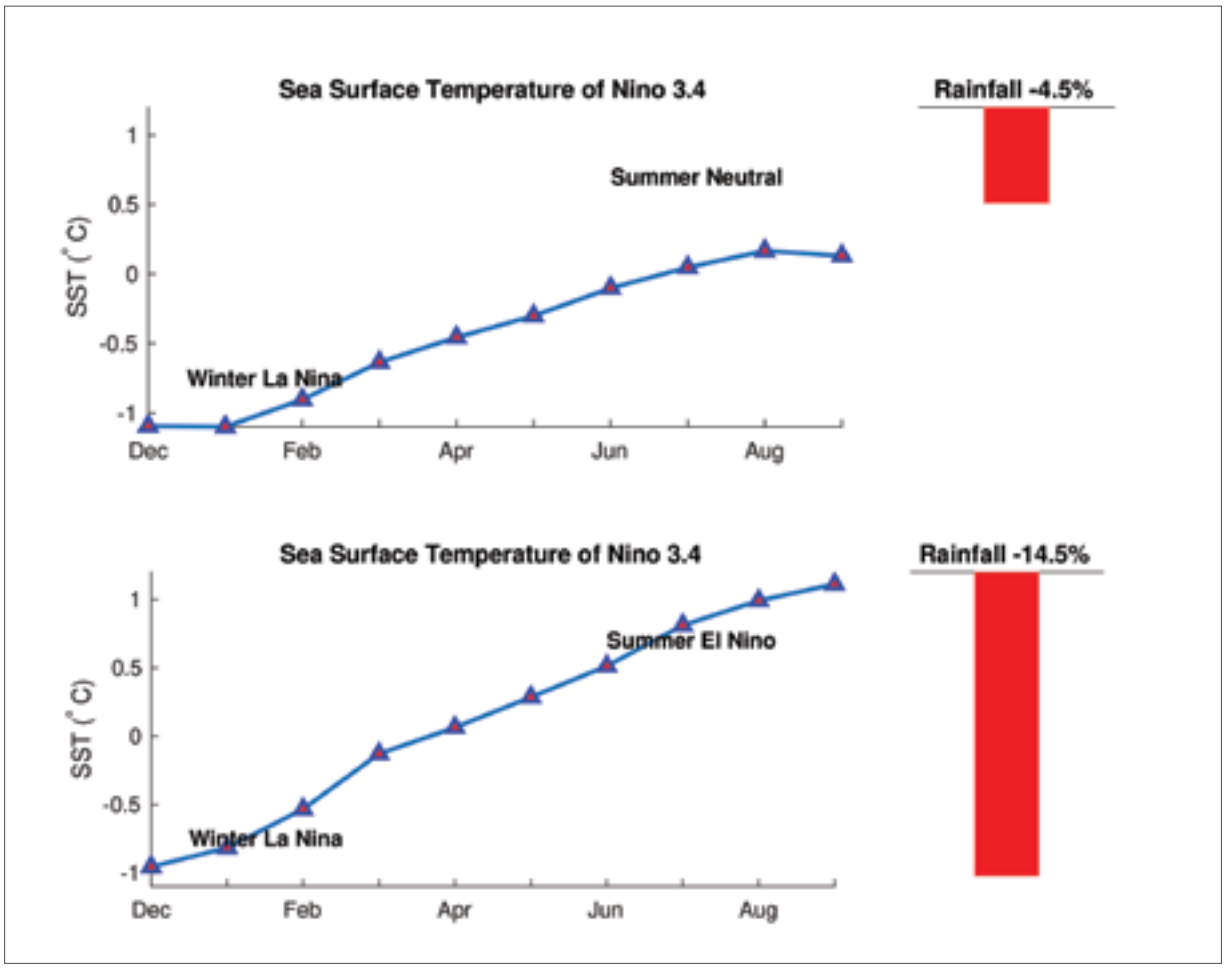
G Hegde (BSSE), KPJ Reddy (AE), D Roy (CiE), R Vasu (IAP)

A major requirement in optical flow visualization for quantitative aerodynamic studies of hypersonic flows is a high speed camera, capable of capturing a few million frames per second

of the flow fields. The IISc team of researchers have designed a low cost wavefront measuring camera that can detect both the amplitude and phase of the captured light wave simultaneously.

(a) Captured I image of the flow field using the developed wavefront camera. Cropped ROI image is processed for vertical density gradients. (c) recovered wavefront d) Recovered 3D-density distribution

Biswajit Medhi, Gopalkrishna Hegde, K.P.J Reddy, Debasish Roy, and R. Vasu, “A novel wavefront measuring camera for quantitative measurement of density in high-speed gas flows”. *Rev. Sci. Inst. 89,* 085122 (2018).



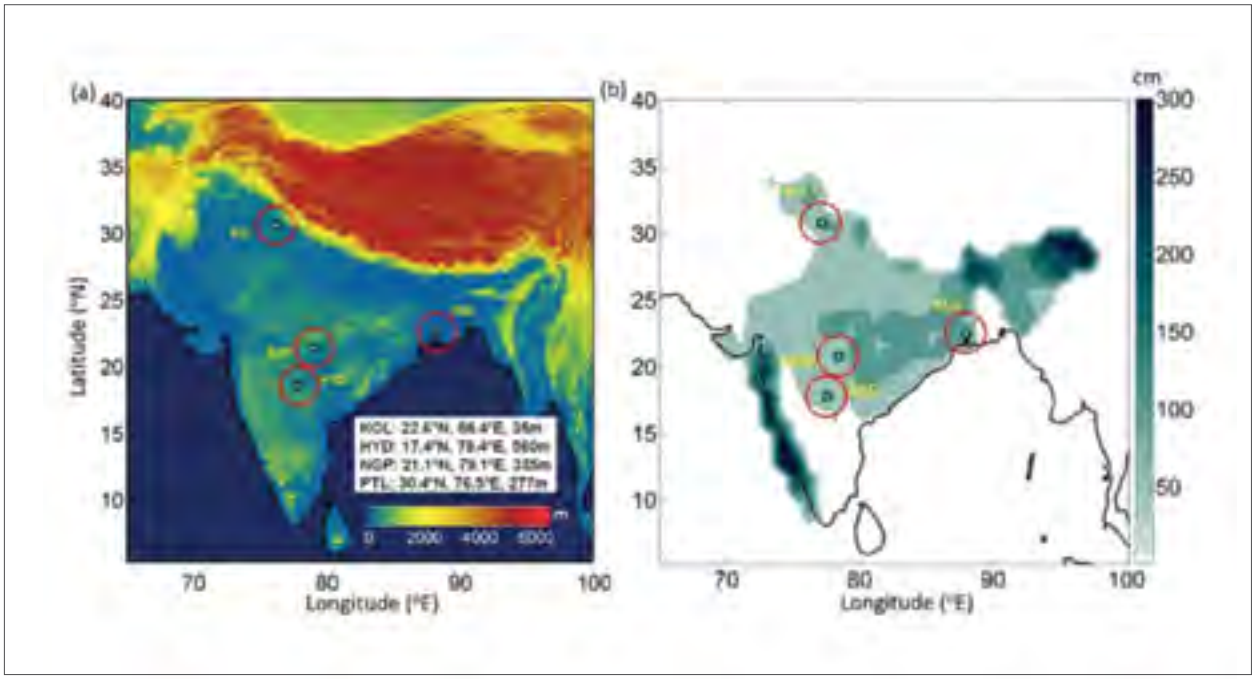
Arindam Chakraborty (CAOS)

The impact of El Nino Southern Oscillation (ENSO) on the Indian summer monsoon has been widely studied for many decades. The warm phase of ENSO, i.e., El Niño, is known to be associated with deficient summer monsoon rainfall. Here it is shown that a La Nina event, i.e., the cold phase of ENSO in the preceding winter leads to below normal seasonal rainfall. Further, when ENSO changes phase from La Niña (winter) to El Niño (summer), the effect on Indian rainfall is severe, foreshadowing drought-like conditions. Our results highlight a fundamental

asymmetry between the two phases of ENSO, and provide a path towards the hitherto elusive seasonal prediction of Indian summer monsoon rainfall.

The evolution of sea surface temperature in the Nino3.4 region in the central and eastern equatorial Pacific ocean (an indicator of El Nino and La Nina). When the northern summer is ENSO neutral (top) following a winter La Nina, rainfall over India is about 4.5% below its long-term mean. On the other hand, if ENSO changes phase from winter La Nina to summer El Nino (bottom), the chances that Indian monsoon will be below normal are high (14.5% below its long-term mean on average).

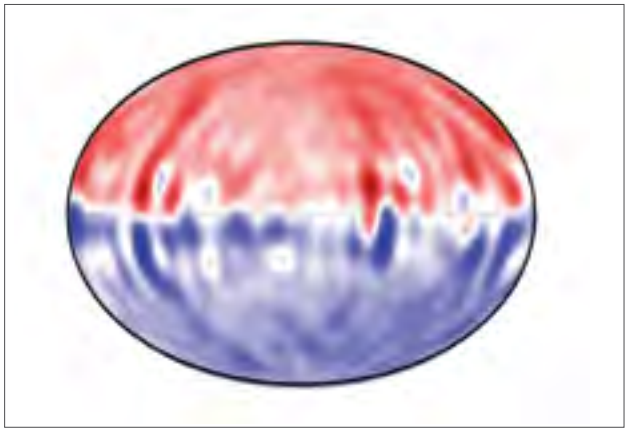
A. Chakraborty, Preceding winter La Niña reduces Indian summer monsoon rainfall, *Environmental Research Letters, 10*.1088/1748-9326/aabdd5, 2018.



GS Bhat (CAOS)

Mesoscale systems (MCS) are cloud clusters that extend to tens to hundreds of kilometres. Embedded within the mesoscale, there are groups of cumulonimbus clouds, or storms, with typical sizes of the order of 10 kms. This study establishes the interconnection between MCS's and storms over India during the 2013 monsoon season. The authors used Doppler Weather Radar (DWR) data of summer monsoon low pressure systems.

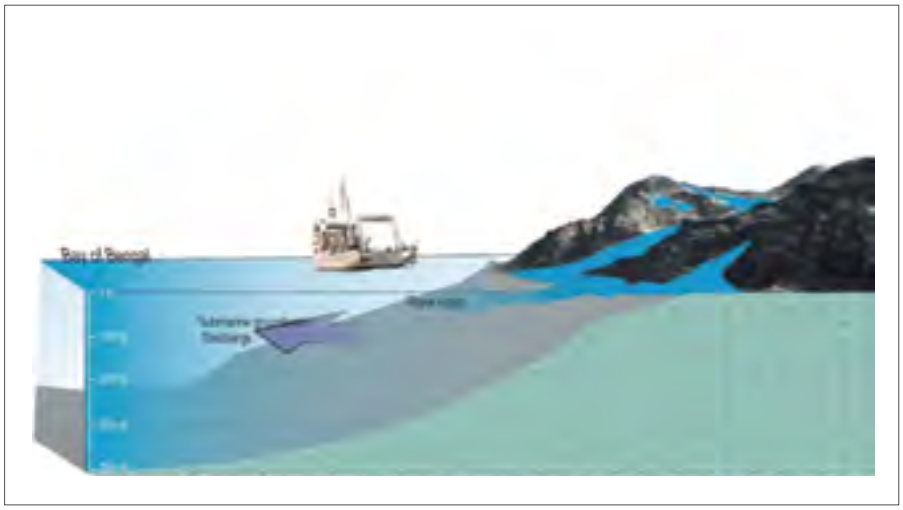
Sindhu K.D. and Bhat G.S. (2018): Characteristics of monsoonal precipitating cloud systems over the Indian subcontinent derived from weather radar data. *Q. J. R. Meteorol. Soc;* 1–19.



B Sreenivasan (CEaS)

The magnetic fields of many planets are approximately axial dipoles. To understand why the dipole is preferred, the evolution in time of a seed magnetic field is studied using a rotating dynamo model. It is shown that the growing magnetic field by itself excites helical convection over a range of length scales within the dynamo region [figure (a)]. The time scale for the growth in convection intensity roughly coincides with the time scale for the formation of the dipole [figure (b)]. It is also shown that the dipole forms from a chaotic state well before the eventual saturation of the magnetic field, implying that a planetary dynamo would have chosen its dominant polarity during its growth phase, i.e. during the early life of the planet.

B. Sreenivasan& S. Kar, Scale dependence of kinetic helicity and selection of the axial dipole in rapidly rotating dynamos, *Phys. Rev. Fluids,* 3, 093801, 2018.



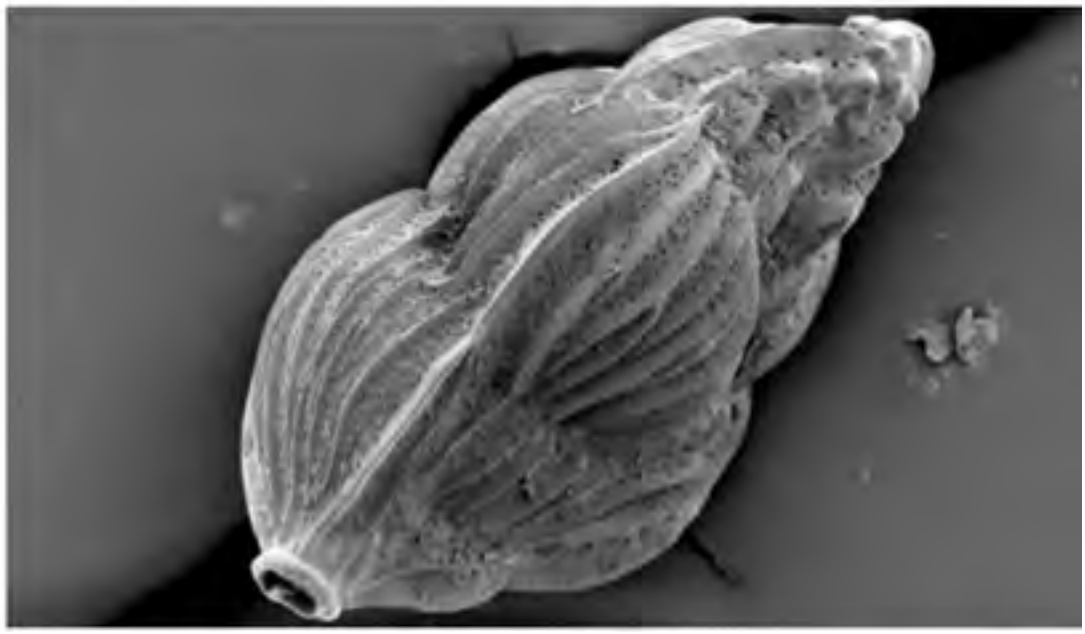
Ramananda Chakrabarti (CEaS)

Large fluxes of dissolved cations and anions, generated by the weathering of rocks, are transported by rivers to the oceans. In addition to rivers, groundwater also carries these ions to the oceans. However, the contribution of the submarine groundwater discharge (SGD) to the

dissolved ion concentrations of the oceans is debated as it is not easily traceable in seawater due to mixing.

In a study published in the journal Scientific Reports of the Nature Publishing Group, Dr.Ramananda Chakrabarti, Surajit Mondal, and Dr. Shiba Shankar Acharya from the Centre for Earth Sciences along with J. SreeLekha and Prof. Debasis Sengupta from the Centre for Atmospheric and Oceanic Science, IISc, have provided a direct evidence of the SGD-driven flux of Strontium (Sr) to the Bay of Bengal (BoB).

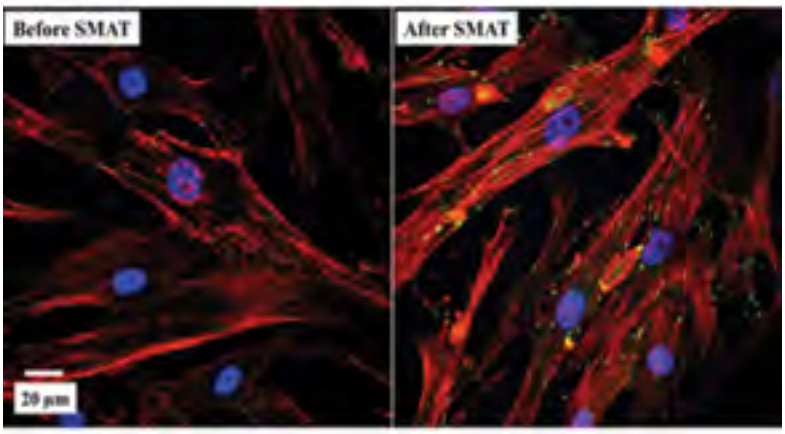
Reference: Chakrabarti, R., Mondal, S., Acharya, S. S., Lekha, J. S., & Sengupta, D. (2018). Submarine groundwater discharge derived strontium from the Bengal Basin traced in Bay of Bengal water samples. *Scientific reports,* 8(1), 4383.



Sambuddha Misra (CEaS)

Nearly 40% of the total CO2 emitted from burning of fossil fuel is absorbed by seawater and the deep-ocean contains nine times more dissolved CO2 than the atmosphere. Microscopic carbonate-secreting organisms living in seawater, like coccoliths and foraminifera (shown in the figure), incorporates trace quantities of dissolved elements from seawater into their calcium carbonate shells. This research discovered that the isotopic composition of lithium, ratio of 7Li to 6Li, trapped within the calcium carbonate lattice is strongly correlated with pH of the organism's growth environment. This result can be used as a new proxy for seawater pH to accurately determine the timing, rate, and extent of natural and anthropogenic alteration of the CO2 budget of the ocean-atmosphere system.

Bohlin, M.S., Misra, S., Lloyd, N., Elderfield, H. and Bickle, M.J., 2018. High-precision determination of lithium and magnesium isotopes utilising single column separation and multi-collector inductively coupled plasma mass spectrometry. *Rapid Communications in Mass Spectrometry,* 32(2), pp.93-104.

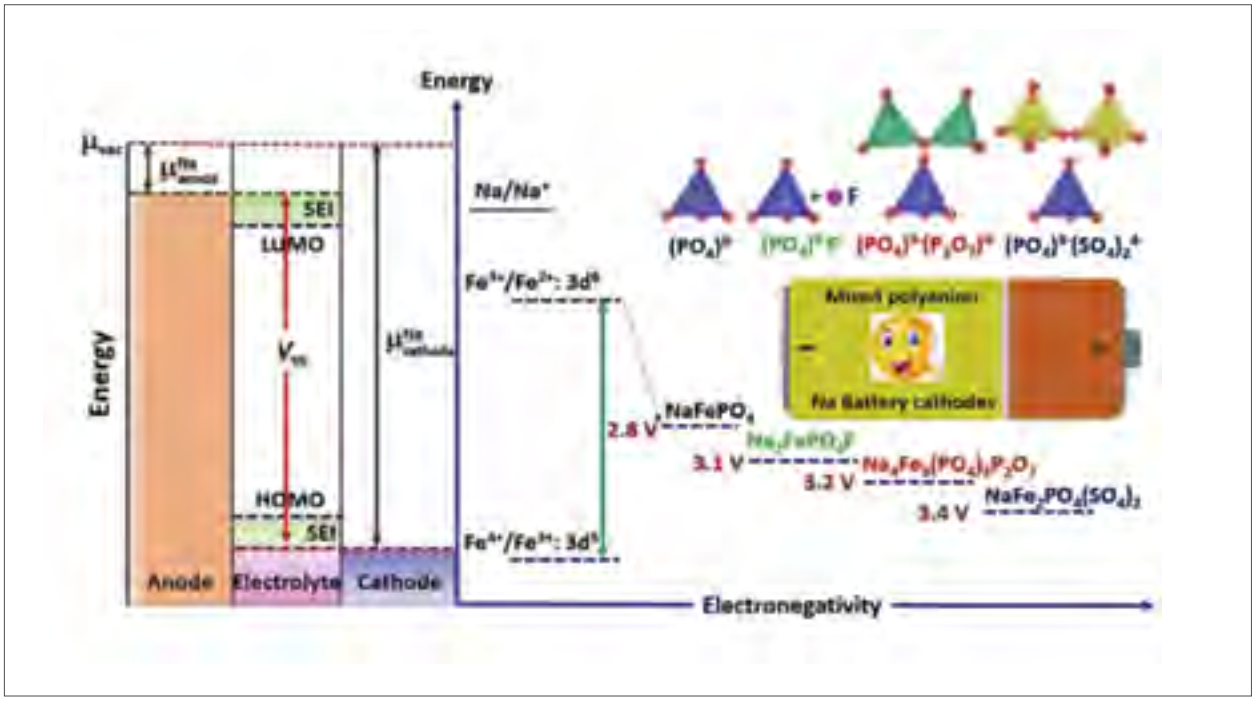


Kaushik Chatterjee (ME)

Metallic implants are used to replace dysfunctional bone joints (hip and knee) in patients suffering from osteoarthritis. The alloys used at present (316L, Ti-6Al-4V, Co-Cr-Mo), are stiffer compared to human bone and contain elements such as Al, V, Ni that have potential cytotoxic effects. Furthermore, they lack the necessary ability to bond with the surrounding bone (termed as osseointegration) or in other words are not bioactive. This has led to the development of new alloys that are less stiff, non-toxic and bioactive compared to existing alloys. In our work, we have developed a new high strength low modulus (less stiff) nontoxic β Ti-Nb-Sn alloy for joint applications. Subsequently, we have employed a facile yet innovative approach to improve the ability of the alloy to bond with the bone.

In this approach, the surface of the alloy is severely deformed by impact of hardened steel balls moving randomly in space at high speed. This process that is used to deform the alloy surface is known as surface mechanical attrition treatment (SMAT).

S. Bahl, S.R.K. Meka, S. Suwas, K. Chatterjee, Surface Severe Plastic Deformation of an OrthopedicTi–Nb–Sn Alloy Induces Unusual Precipitate Remodeling and Supports Stem Cell Osteogenesis through AktSignaling, *ACS Biomaterials Science & Engineering* 4(9) (2018) 3132-3142.

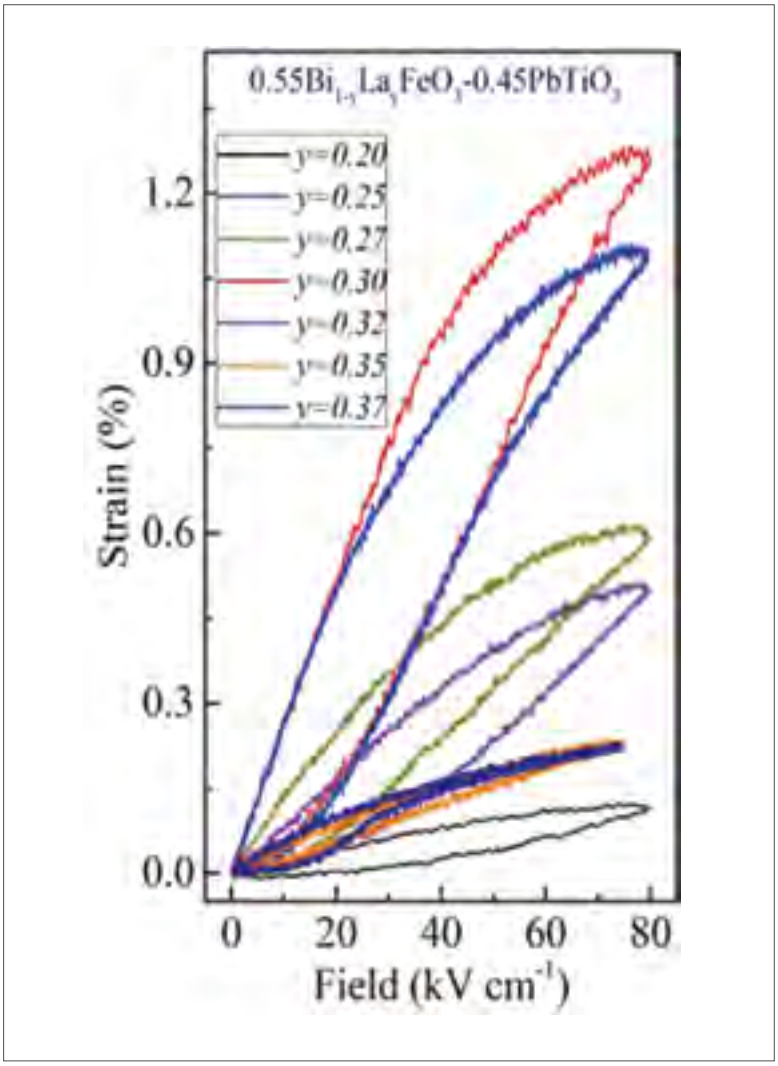


Prabeer Barpanda (MRC)

'Building better batteries' remains an ongoing process to cater diverse energy demands starting from small-scale consumer electronics to large-scale automobiles and grid-storage. While Li-ion batteries have carried this burden over the last three decades, the ever-growing and highly diverse applications (based on size, energy-density and stationary vs. mobile usages) have led to an era of 'beyond lithium-ion batteries'. In this post-lithium-battery genre, sodium-ion batteries (NIBs) have emerged as a pragmatic option particularly for large-scale applications.

Our current work focuses on the world of mixed polyanionic cathode materials to realize the next generation sodium-ion batteries with high energy density.

Reference:
P. Barpanda et al, Adv. Energy Mater, 8(27), 1703055, 2018.



Rajeev Ranjan (ME)

The interesting properties of the class of ceramic materials called “ferroelectric -perovskites” have been used in wide ranging applications such as SONAR, ultrasound imaging, focusing of mirrors in space telescopes, heath monitoring of structures, automobile industry, etc. These materials produce voltage on being stressed and can change shape on application of electric-field. The latter phenomenon is known as electrostrain. The larger the electrostrain, the better the material can perform. Most piezoelectric ceramics exhibits electrostrain in the range ~ 0.2 -0.3 %.

For the first time, we demonstrate that ceramic, which is very easy to make, less time and energy consuming than that required for making of a single crystal, can show electrostrain greater than 1 %. We achieved an electrostrain of 1.3 % by compositional design of the material system BiFeO3-PbTiO3-LaFeO3.

Narayan et. al., Nature Materials, 17, (2018) 427-431