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INSTITUTE COLLOQUIUM
(Divn. Of Interdisciplinary Research)

by
Professor Rudra Pratap
Centre for Nano Science and Engineering (CeNSE)

"Turning Science into Technology:
Narratives of Some Exhilarating Experiences"

Date :Wednesday, 16th March 2016
Venue :Faculty Hall, Main Building
Time : 4-00 p.m.

Prof Anurag Kumar, Director
will preside

Abstract:
Research usually originates from simple curiosity — curiosity to understand a phenomenon or search a solution for a nagging problem. In either case, the methods of scientific research let us dive into the mystries of the universe in amazingly systematic manner. It is this kind of study of nature's mystries that demystify what usually puzzles us first. But is that the end of scientific research? More often than not, our understanding of a phenomenon leads to understanding of other connected phenomena; and soon enough, we have enough information to create something new. This is how we invent new technologies. While serendipity has a role to play in our discoveries, technology is rarely serendipitous; it is usually a result of scientific rigor and systematic hard work. The journey of inventing and creating technologies is quite exhilarating. I present some examples of this experience from our recent work enabled largely by the creation of the Centre for Nano Science and Engineering.

The first example concerns turning a dreaded phenomenon called *electromigration* into a desirable tool for material transport at the nanoscale. Electromigration is an electric field driven phenomenon in which metal atoms in a metallic thin film or line are dislodged randomly from their places due to the *electron wind force* when current flows through the film/line. We have worked on developing precise control on the electromigration process. Wes how that by controlling electromigration, one can harness its power to transport material at nanoscales. We also show, with many experiments on thin chromium films, that controlled electromigration can be used to melt the metal and drive its flow, thus transporting the metal to form certain patterns on micro and nanoscales. The material transport process is complex because of the underlying physics of the multi-phase flow. The mixture of three phases — solid, liquid and air—coupled with an electric field, provides enough number of process variables that, if controlled precisely, can be used for rapid patterning of metal films. After a thorough understanding of how solid and liquid electromigration processes work, we turn our understanding into a fascinating technology that we call *Electrolithography*. **The second example** concerns the study of a natural transuder for loud sound production from a very small source. We have studied the mechanism used by the field crickets to produce sound (crickets do not have vocal cords like human beings or other animals). It is a fascinating micro-mechanical mechanism with three distinct parts—an actuator (the stridulation of wings), a frequency multiplier, and a resonator (the *harp* embedded in the

wings). We subsequently use our understanding of this bioacoustic transducer to design tiny MEMS (Micro-Electro-Mechanical Systems) speakers that produce similar sound. Thus we turn our curiosity driven research on cricket song to a technology for producing micro-speakers. **The Third example** comes from our long study for understanding the dynamic response of microscale structures and MEMS devices. After probing hundreds of vibrating structures and perfecting methods to measure sub-nanometer amplitude vibrations, we turned our attention to exciting biological cells, obtaining their vibration signatures, and analysing the recorded signals for pathology detection. We are now at a threshold of perfecting a technology for what we call *mechano-diagnostics*. Finally, I will also present a ring-side view of a technology coming out of CeNSE that is likely to change the Indian technology landscape forever.

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Tea : 5-00 p.m.

ALL ARE WELCOME