In this issue

Chalk: Quality of Writing

And board that wipes easily

All who read this have, sometime or the other, been exposed to chalk and board. We have all experienced problems in reading what is written on the board, difficulties in wiping it clean for the next class, and the huge amount of dust generated! White boards and PowerPoint presentations have not entirely wiped out the chalk and board industry. An estimated need in India is about 20,000 tonnes of chalk per annum.

To improve the quality of this educational tool that refuses to be replaced, scientists from the CSIR-Central Salt and Marine Chemicals Research, Bhavnagar, the CSIR-National Chemical Laboratory, Pune, and the Institute of Chemical Technology, Mumbai, undertook a series of experiments. In a General Article on **page 1727** in this issue, they report their efforts at understanding the properties and qualities of the boards, chalk and duster. The industries that supply the educational system can now make informed decisions to improve the experience of the few hundred million students in Indian classrooms.

Nanoparticle Assemblies

Recently, in IIT Bombay, there was a meeting of scientists interested in nanoparticle assemblies. And some scientists distracted themselves from the immeasurable advances taking place in the field to look at the immense lacunae in our understanding. They hungered to bring together the basic principles that will help us make sense of the data pouring out from labs in different parts of the world, and to move from the currently adopted trial and error experimentation to a theoretically informed testing and developing of applications.

Consider, for instance, the tendency of nanoparticles to behave differently, depending not only on the material, but also on the size, shape and surface chemistry. In certain applications the particles need to be ordered, without any defects, whereas in some others, the most disordered state is preferred. There is as yet no common principle to design nanoparticles for such specific functions.

It is now possible to routinely synthesize large quantities of nanoparticles with desired size distribution, chirality and surface functionalization. But in assembling them for use in applications, we have no guiding theory or even framework. The biologically inspired self-assemblies have gained momentum, but again, mostly through experimental explorations.

The data generated already, should give us patterns just like the periodic table streamlined our understanding of the ever growing number of elements – reasoned the scientists. In a General Article on **page 1635** in this issue, they present overarching questions in the field that require immediate attention, to enable the creation of function-driven nanoparticle assembly design to meet the requirements of applications in catalysis, in conversion of solar energy, and for creating materials with unique optical and optoelectronic properties.

Submicrometer 3-D Structures

Photons fix voxel size

We can create miniature 3-D structures using electron beam lithography and focused ion beam milling to etch materials. But the energy requirement is high and the processing times are large. Photolithography is less costly, but has limitations of resolution. Multiphoton lithography, on the other hand, has advantages: the polymerization can be localized to sub-wavelength dimensions and it can be used to fabricate highly complex 3-D structures with spatial resolution far smaller than 100 nm. Multi-photon laser writing is done using titanium : sapphire lasers that can generate femtosecond pulses at 780 nm. But these, again, mean high equipment cost.

So engineers in the Indian Institute of Technology, Kanpur, rigged up a two-photon laser writing system using a sub-nanosecond low cost Q-switched Nd : YAG microlaser operating at 532 nm wavelength. To achieve this, they used a combination of two photoresists in the target material. This, along with tight focusing, helped reduce the threshold of polymerization. And thus they could achieve what higher power femtosecond lasers do, at much lower costs.

In a Research Article on **page 1668** in this issue, they describe how they optimized 3-D structuring to achieve submicrometer voxel dimension. (Voxel is to 3-D, what pixel is to 2-D.) The system has large depth aspect ratio even when used as a 2-D writer.

Such 3-D sculpting systems have applications in the fields of plasmonics, memory devices, photonic devices and sensors.

Environmental DNA

On tools and methods

The tools and methods of genetic research developed in the last three decades have given a new impetus to scientific research. The analysis of DNA in soils, water and air can now provide us clues even about organisms unseen and unheard of earlier. Researchers from the Chongqing Normal University, China, now give us a review of research on environmental DNA on **page 1659** in this issue.

Reviews are usually written by first compiling the papers on a topic published in the recent months, synthesizing the results from many papers to create a logical and easily understandable framework and to highlight the major advances. But scientometrics has now made it possible to review a field from a much higher angle by covering thousands of papers published over decades. This vantage view point from the shoulder of taller giants can show you more than ordinary reviews.

What is interesting is that the tools and methods of scientometrics used by the researchers are slowly becoming more user-friendly and the time is not far when Ph D scholars would routinely undertake such studies before embarking on their research.

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