Breakthrough

BRINGING IDEAS TO LIFE

Purifying Each Drop

Professor Pradeep T

Professor Pradeep has been mentoring students working for their doctoral thesis for many years now. During his stint as a Professor at the Department of Chemistry and Sophisticated Analytical Instrument Facility at the Indian Institute of Technology Madras (IIT-M), Professor Pradeep

made a startling discovery about nano particles.

One of Pradeep's doctoral students was Srikumaran Nair, whose thesis was on nano particles. As this is still a nascent field, Professor Pradeep closely monitored his progress and during one of the lab experiments, the discovery they made allowed them to use nano particles to successfully purify drinking water.

Professor Pradeep's research group are not armchair scientists who theorise without actually getting their hands dirty. These young scientists involved in extensive lab work have made significant progress in their studies. The group is primarily involved with new materials, whose constituents are often 'nano' objects. The group studies the nano objects intricately and explores the possibility of discovering novel physical and chemical properties of these objects.

Some of their investigations have led to viable technologies. Their studies contributed to the understanding of the structure of molecules in nano scale assemblies. On the nano scale, these scientists discovered new reactions of materials and developed novel applications of nano particles. Some products based on the research done by the group have already been commercialized.

These bright minds spend extensive amounts of time studying ice, especially the surface of ice, where they discovered the new phenomena.

Category of Innovation	:	*Academic and Institutional Research*
Area of Innovation	:	*Water and Sanitation*
Name of the Innovator	:	*Professor Pradeep T*
Name of the Institution	:	*IIT Madras*
Place	:	*Chennai*
Commercialised	:	*Yes*
What is the Innovation	:	*Nano-particle based Water Filter*

They discovered a new oscillatory phenomenon on ice surfaces and found that small kinetic barriers were able to arrest even simple reactions. "Let me start at the beginning," laughs Professor Pradeep when he tries to explain Carbon-Chlorine bonds. Chloro-fluorocarbons (CFCs) are known to deplete the ozone layer.

These are referred to as "reservoir species"—independently, these chemicals do not react with ozone. However, they do decompose to some extent, creating, among other things, a small amount of atomic chlorine, and chlorine monoxide, which can catalyze the destruction of ozone by a number of mechanisms.

All water purification systems under the Eureka Forbes banner utilise the nano particles technology developed by Professor Pradeep and his team.

"Everyone knows that ozone depletion is a big problem. However, for us getting rid of the halocarbons was the real issue," says Professor Pradeep.

Apparently the CFCs themselves do not destroy ozone; some of the decay products that they expel are the real culprits. After CFCs are photolyzed (photolyzation is a process that breaks down complex molecules using light), most of the chlorine eventually ends up as Hydrogen Chloride.

The Study and the Discovery

The Professor then begins to explain what the carbon-chlorine bond is. "The carbon-chlorine bond is a strong one and using nano particles we were able to break down halocarbons," says Professor Pradeep.

This discovery stunned the scientists because CFCs are a hazard to our environment mainly because the halocarbons that deplete the ozone

Professor Pradeep displaying the nano-particle water filter in his lab

cannot be destroyed. If it was possible for halocarbons to be destroyed, then the CFCs would no longer be a problem.

Not only were the team able to destroy halocarbons, they did it at room temperature. "We couldn't believe our eyes when we realised that the breaking of the carbon chlorine bond, one of the toughest bonds happened in one of our labs and at room temperature," Professor Pradeep said.

Once they realised that by using nano particles they had actually achieved the impossible, the group wanted to expand their research and check if this miraculous feat could indeed be repeated on a different medium.

Immediately, the group proceeded to use nano particles to test whether the carbon-chlorine bond could be broken in water. This too happened and at room temperature again.

"We stood at the brink of something amazing; here was the potential for us to actually make a difference," says Professor Pradeep. Indeed, it was a mighty difference they were about to make. The endosulfan contamination in the farmlands of Kerala was a major scandal.

Not only were major multi national conglomerates forced to withdraw popular food products contaminated by this dangerous chemical, but, it also affected the lives of millions of people in just one state. Throughout the country, the pesticide contamination in water was devastating!

Endosulfan is a neurotoxic organochlorine insecticide. It is an endocrine disruptor and is acutely toxic. It is banned in more than 50 countries, including the European Union and several Asian and West African nations.

However, it is still used extensively in many countries including India, Brazil, and Australia. Because of its high toxicity and high potential for bioaccumulation and environmental contamination, a global ban on the use and manufacture of endosulfan is being considered under the Stockholm Convention.

"Our nano particles purifying water had to be tested and so we used real drinking water samples to check if the nano particle usage could be replicated constantly and we were delighted with the results."

The Water Filter

During their research, the group discovered that noble metal nanoparticles could completely degrade halocarbons into amorphous carbon and metal halides. This discovery had positive ramifications that would not be so hard for the common man to understand.

There are many important aspects of this novel discovery: with the complete degradation of halocarbons, it was now possible to extend this study to toxic pesticides. Since most of the toxic pesticides were made up of halocarbons, this could impact the common man.

In addition, there was an eco-friendly angle to this entire project as the end-products created when the carbon

chlorine bonds are broken are harmless. This means that the study found an efficient way of removal of pesticide residues in drinking water and by using a simple visual, colour-based detection system for pesticide detection, it has succeeded in making a scarce and precious resource safe for millions.

As it needs zero electricity usage, this technology is likely to be of tremendous use to the rural population of India which has been badly affected by the pesticide contamination. The technology has been commercialized and a nano particle-based water filter, the first of its kind, has been introduced in the market in partnership with Eureka Forbes Limited. "In fact when we conducted the study, we did so with gold and silver nano particles," says Professor Pradeep.

Once it was established that even toxic pesticides could be eliminated, this technology was ready for commercialisation. In June 2007, the Indian market was introduced to Aquaguard Gold Nova which incorporated gold nano particles.

Soon Eureka Forbes saw the potential in the technology and upgraded its existing portfolio and now, all the water purification systems under the Eureka Forbes banner utilise the nano particles technology developed by Professor Pradeep and his team to make drinking water safe for us again.

"This example of academic-industry partnership in advanced technology makes us realise that the problems of our nation can be solved right here in our own labs," says Professor Pradeep.