## EMERGING RESEARCH FRONTS - 2009

### October 2009

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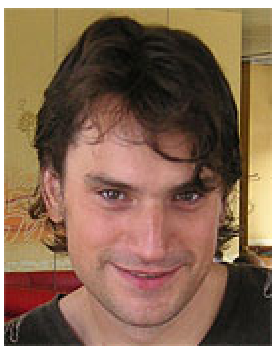
**Wolfgang J. Parak & Liberato Manna talk with *ScienceWatch.com* and answer a few questions about this month's Emerging Research Front Paper in the field of Materials Science. The authors have also sent along an image of their work.**



**Article: Hydrophobic nanocrystals coated with an amphiphilic polymer shell: A general route to water soluble nanocrystals**
Authors: Pellegrino, T;Manna, L;Kudera, S;Liedl, T;Koktysh, D;Rogach, AL;Keller, S;Radler, J;Natile, G;Parak, WJ
Journal: NANO LETT, 4 (4): 703-707 APR 2004
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(addresses have been truncated.)

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**SW: Would you summarize the significance of your paper in layman's terms?**

Colloidal nanoparticles are emerging new materials which have the potential for use in many different disciplines ranging from electronics (solar cells, LEDs) to the life sciences (fluorescence labels). The wet chemical synthesis of nanoparticles has experienced a great upsurge during the past decade.

Today, colloidal nanoparticles can be made out of a huge variety of materials and the current synthetic routes allow for the tailoring of their size, shape, and also for combining different particles to form hybrids.

For most materials, the synthesis in organic solvents is preferred, as a wider range of temperatures and surfactants is available. However, the resulting particles are hydrophobic and thus cannot be used for most applications in the life sciences.

Early approaches tried to circumvent this problem by subsequent ligand exchange. However, for many materials the resulting particles possess only limited colloidal stability, particularly when salts are present, as is the case in all body fluids. Naturally, medical use of unstable particles is excluded.

The paper describes an important step towards the solution of this problem. Instead of performing a ligand exchange, which depends on the chemical nature of the surface of these particles, this approach is based on a more general principle.

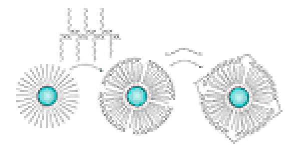
Addition of an amphiphilic polymer leads to the water-solubility of the particles. The hydrophobic tails of the polymer intercalate the hydrophobic surfactant molecules originally present on the particles' surface, whereas the hydrophilic backbone of the polymer is exposed to the environment and thus renders the particles water-soluble.

The considerable advantage of the procedure stands in its generality. As the whole coating procedure is only based on hydrophobic interaction, it can be applied to virtually all nanoparticles possessing a hydrophobic surfactant shell. The resulting particles have a significantly higher colloidal stability and thus resist aggregation to a much better extent. Even though the polymer contributes to a slight enlargement in the size of the particles, the resulting particles still are quite small and many commercially available particles are nowadays distributed with similar surfaces.

The basic idea of this work originated in the group of Paul Alivisatos, who is currently the Larry and Diane Bock Professor of Nanotechnology at the University of California, Berkeley, where Liberato Manna and Wolfgang Parak were both working almost a decade ago as postdocs. In the Alivisatos lab, they were first introduced to the beauty of colloidal nanoparticles.

Coauthor
Liberato Manna

Figure 1 [+]enlarge



Hydrophobic nanoparticles are stabilized in organic solvents by hydrophobic surfactant molecules present on their surface. Addition of an amphiphilic polymer with hydrophobic side-chains and a hydrophilic backbone renders the particles watersoluble

While Liberato Manna focused on growing particles in organic solvents, Wolfgang Parak was dedicated to their transfer to an aqueous solution and their use in biology. Both discussed the problems of limited colloidal stability of these particles.

Back in Europe, both researchers started working towards a solution of this problem. Together with Teresa Pellegrino, who also originated from the Alivisatos group, they developed the idea of adding an additional layer to the particle surface instead of exchanging the existing one.

They were all working at the Ludwig Maximilians Universität at the Center for Nanoscience at the time when they put their ideas into practice. Their development ran somehow parallel to the research of the Quantum Dot Corporation in Hayward, California, which, at the same time, introduced a similar polymer-coating procedure.

As colloidal stability is paramount for life science applications—i.e., who wants to work with aggregates?—the polymer coating procedure soon was accepted in the field. So far, many groups have reproduced and actually improved upon the procedure in a variety of ways, which has led to a large number of citations of our original work.

As the procedure is general, it is nowadays used for several types of nanocrystals, ranging from fluorescence quantum dots up to magnetic nanoparticles. As applications in the life sciences are starting to emerge, the method developed by Manna and Parak surely will have an increasing impact into the future.

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LUMINESCENT; PARTICLES.

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