FAST MOVING FRONTS - 2009

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Takashi Uemura & Susumu Kitagawa talk with *ScienceWatch.com* and answer a few questions about this month's Fast Moving Front in the field of Materials Science.

Article: Prussian blue nanoparticles protected by poly (vinylpyrrolidone)
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Journal: J AM CHEM SOC, 125 (26): 7814-7815 JUL 2 2003
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SW: Why do you think your paper is highly cited?

Coordination polymers composed of transition metal ions and bridging ligands have shown many prominent features—such as magnetic, optical, electrical, and porous properties, etc.—during the past decade. In order to apply these fascinating properties to nanosize materials, the understanding of their size effects in the nanometer-size regime is highly important.

Prussian blue (PB) analogs are representative of coordination polymers and have played important roles in the field of molecular magnets. In this paper, we showed a facile preparation method of size-changeable PB nanoparticles, using an organic polymer as a protecting agent, and demonstrated new size-dependent magnetic properties of PB. We believe that our work has opened up new directions in the fields of not only inorganic chemistry, but also that of the physical and materials sciences, which may have resulted in the high citation rate.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

We have shown three new and important features which have attracted the interest of many researchers. These are as follows:

1) PB nanoparticles could be easily prepared by the addition of an organic polymer into the reaction mixture, and the size of the nanoparticles was controllable by changing the feed ratio of the polymer.

2) Although bulk PB is not soluble in organic solvents, our PB nanoparticles could be dissolved in many organic solvents because of their miniaturized size and polymer protection. It was of interest that the PB nanoparticles were remarkably stable in an organic solution

without a size-change.

3) The PB nanoparticles exhibited a quite different magnetic behavior from that of the bulk PB, and have also shown the first example of a size-dependent magnetic property of the coordination polymers.

Coauthor
Susumu Kitagawa

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

Before this work appeared, researchers focused only on the bulk properties of coordination polymers. Therefore, no one knew of the properties of coordination polymers characteristic of the nanometer regime. In this paper, we have demonstrated, for the first time, nanosize properties of a coordination polymer.

SW: How did you become involved in this research and were any particular problems encountered along the way?

Tremendous attention has been given to size-controlled particles consisting of metals, metal oxides, and metal sulfides, because of their many interesting properties which are significantly different from the corresponding bulk materials. It is also well-known that organic polymers show molecular-weight-dependent features such as solubility, viscosity, conductivity, film-forming properties, and so on. Even though the coordination polymers are named "polymer," studies on the molecular weight (crystal size) effect had not been explored at that time and this is the reason why we focused our attention on this area.

SW: Where do you see your research leading in the future?

The concept described in this paper can be extended to produce a variety of nanomaterials, and actually, many works on coordination polymer nanoparticles have appeared recently. Formation of nanomaterials based on coordination polymers would display advanced and characteristic functions, such as flexible, porous, and chiral properties, which are different from those observed in the conventional metal or metal-oxide systems.

SW: Do you foresee any social or political implications for your research?

Organic–inorganic hybrid nanocrystals are a new class of materials that combine the flexibility of the electronic structure and the versatile architecture of coordination systems, which will provide new functionalities at the nanoscale. These coordination polymer nanomaterials will be applied to sensors, memories, imaging, catalysts, drug delivery, etc., and can open up new dimensions within the field of nanomaterials science.

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KEYWORDS: NANOCRYSTAL SUPERLATTICES; MAGNETIC-PROPERTIES; MICROEMULSIONS; TEMPERATURE; CHEMISTRY; DESIGN.

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