ScienceWatch Home
Inside This Month...
Interviews

Featured Interviews
Author Commentaries
Institutional Interviews
Journal Interviews
Podcasts

Analyses

Featured Analyses
What's Hot In...
Special Topics

Data & Rankings

Sci-Bytes
Fast Breaking Papers
New Hot Papers
Emerging Research Fronts
Fast Moving Fronts
Corporate Research Fronts
Research Front Maps
Current Classics
Top Topics
Rising Stars
New Entrants
Country Profiles

About Science Watch

Methodology
Archives
Contact Us
RSS Feeds

new hot papers - 2010

May 2010

PDF

Yong Zhang talks with *ScienceWatch.com* and answers a few questions about this month's New Hot Paper in the field of Materials Science. The author has also sent along images of his work.

2008 *ADVAN M*ATER paper, "Multicolor Core/Shell-Structured Upconversion Fluorescent Nanoparticles Article Title: Multicolor Core/ Shell-Structured Upconversion Fluorescent Nanoparticles
Authors: Li, ZQ;**Zhang, Y**;Jiang, S
Journal: ADVAN MATER
Volume: 20
Issue: 24
Page: 4765-+
Year: DEC 17 2008
* Natl Univ Singapore, Div Bioengn, Singapore 117574, Singapore.
* Natl Univ Singapore, Div Bioengn, Singapore 117574, Singapore.
(addresses have been truncated.)

SW: Why do you think your paper is highly cited?

This paper reports on the synthesis of near-infrared (NIR)-to-visible (VIS) upconversion fluorescent nanoparticles and their use in biological applications. Although upconversion fluorescent nanoparticles present a relatively new area of research, the wide attention that this paper has received reflects upon the increasing interest that it has spurred amongst the scientific community.

I think this paper is highly cited because it touches on a subject that is of wide-ranging relevance and which is also being actively pursued by various researchers of diverse backgrounds, beginning from lead-user material scientists to end-user biologists.

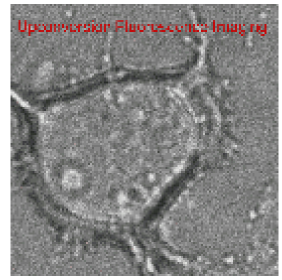
Indeed, it has aroused much interest, as it outlines the development and application of a fluorescent material that has the potential to overcome major challenges which other fluorophores have faced during the past several decades, while also specifically addressing issues that used to be technologically challenging in making upconversion fluorescent nanoparticles with well-controlled sizes, shapes, surfaces, and multicolor properties.

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

The paper described a new method to synthesize core-shell structured upconversion nanoparticles with multicolor emission. The traditional route of synthesizing these upconversion nanocrystals is normally done in organic solvents or at high temperatures.

Although some chelating agents, such as ethylenediaminetetraacetic acid (EDTA), have been employed to control the growth of the nanocrystals, these resultant nanocrystals can only be dispersed in some organic solvents to form colloidal solution after sonication.

In this paper, we have developed a facile and user-friendly method to produce uniform hexagonal-phase nanocrystals with strong upconversion fluorescence at low temperature and silica-coated nanoparticles with core-shell structure and having multicolor upconversion emission.



Upconversion Flourescence Imaging

View/download two accompanying slides and descriptions.

PDF

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

Today's commonly used fluorescent probes are mainly based on downconversion materials requiring excitation by short-wavelength light (e.g. organic dyes, quantum dots, and green fluorescent proteins).

Their use remained problematic due to several drawbacks, such as high rate constants for photobleaching, short penetration depth, and strong autofluorescence background, all of which decreases the sensitivity and efficiency of detecting the fluorescent signal and thus, consequently, hampers their use for more varied applications.

On the other hand, NIR-to-VIS upconversion nanomaterials dismissed the need for such excitation by short-wavelength light. Rather, they can convert NIR light to VIS light upon NIR light excitation.

Since all biomolecules absorb minimally in the NIR window, this will solve current problems associated with the use of illumination by short-wavelength light, such as autofluorescence background, low light penetration depth, and photodamage to biological specimens. These upconversion materials also show negligible photobleaching.

Endowed with all these favorable properties, upconversion fluorescent materials show a great potential for use in diverse bio-applications, including, but not limited to, deep-tissue imaging, detection of low abundant sub-cellular components, gene delivery and tracking, photo-controllable gene expression, and targeted photodynamic therapy against cancer.

It is also anticipated to leave room for applications in many other research areas, examples of which include solid-state lasers, flat-panel displays, solar cells, and so forth.

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

My involvement in nanoparticle research began during my postdoctoral fellowship at the University of Washington in Seattle, where I was then focusing mainly on magnetic nanoparticles. Later on, when I moved on to take a faculty position in the Division of Bioengineering at National University of Singapore, I found research on quantum dots to be quite interesting.

However, after spending two to three years on doing research on quantum dots, I encountered many problems with quantum dots that have yet to be resolved. Not only do we face problems with synthesizing these materials, but their intrinsic properties, such as cytotoxicity, has also posed a limitation on their potential applications.

"I think this paper is highly cited because it touches on a subject that is of wide-ranging relevance and which is also being actively pursued by various researchers of diverse backgrounds, beginning from lead-user material scientists to end-user biologists."

This had thus sparked in me an urge to explore other new materials that could possibly replace the caveats faced in using quantum dots. It was then that I found lanthanide-based upconversion nanoparticles.

Due to their unique optical properties, I instinctively knew that this is the material which I had been looking for all along. So that was how we embarked on our research in upconversion nanoparticles.

At the beginning, we focused on the development of new methods for synthesizing this material. By using existing methods reported in the literature, only upconversion nanoparticles that were not biocompatible and not dispersible in water could be produced, and as such their use for bio-related applications was limited.

Furthermore, the particles were too large in size, unstable in solution, and their surface was non-functionalized, thus making conjugation of biomolecules impossible. There was no commercial equipment that could be used to capture images of the upconversion fluorescence in biological systems.

Today, we have resolved these issues by developing a facile synthesis method to produce biocompatible upconversion nanoparticles with a suitable surface and good dispersibility in water for use in bioimaging, biodetection, photodynamic therapies of viruses and cancer, photo-controllable gene expression, and possibly even more. We have also set up a custom-fitted confocal microscope and animal imaging system and are proud to be pioneering in this area as well.

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

I can foresee that upconversion nanoparticles will become the next generation of ideal fluorophores. Their potential for use in biological and even clinical applications is wide-ranging, from biolabeling and bioimaging to photodynamic therapy and photo-controllable gene expression, and perhaps even in photo-induced micropatterning.

As such, there is huge potential for their commercialization. As part of our continuous efforts in producing nanoparticles with improved qualities, development of a new synthesis route to produce nanocrystals with reduced size and high upconversion efficiency is already underway.

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

Though still a far-fetched idea, the potential of upconversion nanoparticles for use in clinical settings, such as photodynamic therapies against viruses and cancer, can possibly provide an alternative and better treatment modality to overcome the flaws of our existing ones.

Yong Zhang, Ph.D.
Associate Professor
Division of Bioengineering
National University of Singapore
Singapore

KEYWORDS: CONVERTING PHOSPHOR REPORTERS; IMAGING IN-VIVO; QUANTUM DOTS; 2-PHOTON EXCITATION; NAYF4 NANOCRYSTALS; GOLD NANORODS; LATERAL-FLOW; CANCER-CELLS; LUMINESCENCE; SILICA.

PDF

back to top