A Shining Example of Doping

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The use of organic fluorophores as contrast agents for bioimaging enables noninvasive detection and real-time visualisation of biological processes at spatial scales from molecules to whole organisms. Although optical bioimaging with fluorophores has become the state of the art with the potential to impact fundamental biomedical research and clinical practice, it is not without limitation and complication. These fluorescent materials have broad emission spectra unsuitable for mutiplex biolabeling and often suffer from photodegradation on exposure to external illumination. Quantum dots that feature large molar extinction coefficient, high quantum yield, narrow emission bandwidth, size-dependent tunable emission and high photostability are attractive as alternative luminescent labels for optical labeling and imaging. However, the use of quantum dots for biological detection is limited by several factors. The potential toxicity of quantum dots that may pose risks to human health and the environment under certain conditions has been a matter of much debate. Intermittent emission (blinking) also limits their use for labeling individual biological molecule. The drawbacks of the dyes and quantum dots in biological applications have prompted the development of a new class of lanthanide-doped (for example, erbium or ytterbium) nanomaterials termed as upconversion nanoparticles. Upconversion nanoparticles emit visible light when illuminated with near-infrared light, where biological molecules are optically transparent. In addition, these nanoparticles show sharp emission bandwidth, long lifetime tunable emission, high photostability, and low cytotoxicity, which render them particularly useful for bioimaging applications.

SHINING EXAMPLE OF DOPING | NUS goes green!


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可改变3D电影制作并降成本

IN THE NEWS | ***Lianhe Zaobao***, Section 1, p10, Singapore and Saudi Universities Cooperate To Develop New Material That Could Change The Way 3D Films Are Made And Cut Costs, 25 February 2010

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To this regard, Assistant Professor Liu Xiaogang and his team comprising Dr. Wang Feng, Associate Professor Hong Minghui, Assistant Professor Zhang Chun, Dr. Lim Chin Seong, Dr. Lu Yunhao, and Ms. Wang Juan have recently developed a new strategy for the synthesis of ultra-small upconversion nanoparticles with controlled properties. We show that the size, symmetry and optical properties of luminescent $NaYF_4$ nanocrystals can be tuned by adjusting the concentration of lanthanide ions incorporated into the crystal lattice. These $NaYF_4$ nanocrystals can adopt cubic or hexagonal symmetry: the hexagonal crystals emit light more efficiently, but synthesizing them with the ultra-small dimensions useful for applications has till now required hazardous reaction materials, high temperatures and long reaction times.

We show that introducing larger lanthanide ions, such as gadolinium, into the $NaYF_4$ lattice favours the hexagonal structure. In addition, by varying the composition and concentration of these dopant ions, both crystal size and the colour of light emitted can be varied. The method, which works at lower temperatures with shorter reaction times, should be readily extendable to other lanthanide-doped nanocrystal systems, with applications ranging from bioimaging to three-dimensional displays. The work was recent published in ***Nature*** and highlighted in ***Lianhe Zaobao*** (view article).

Publication

Dr Liu Xiaogang - "Simultaneous phase and size control of upconversion nanocrystals through lanthanide doping" (***Nature***, 463(7284), 1061-1065)