Crystal clear: Thousand-fold fluorescence enhancement in an all-polymer thin film

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Griffith University scientists have made a remarkable breakthrough in the field of fluorescence enhancement via a discovery they believe could drive the next advances in sensor technology, energy saving and harvesting, lasers and optoelectronics.

A research team led by Dr Qin Li, from Griffith's Queensland Micro- and Nanotechnology Centre, is reporting unparalleled magnitude of fluorescence enhancement due to a novel and multi-layer Colloidal Photonic Crystal (CPhC) structure.

According to Dr Li, the researchers discovered that a double heterostructure tri-layer CPhC - with the stopband of top and bottom layers overlapping the excitation wavelength, a middle CPhC layer in resonance with the emission wavelength, and a thickness supporting constructive multiple beam interference for excitation light—resulted in a thousand-fold fluorescence enhancement in an all-polymer structure compared to that achieved by the same amount of dyes on glass substrate.

"Furthermore, we found that the enhancement of fluorescence intensity due to the double heterostructure is almost six times that of monolithic CPhCs," says Dr Li.

"What is even more intriguing is that the emission lifetime constant has been shortened by fourfold," says Dr Li.

The findings are the culmination of two years of research involving teams from Australia and China, including world-leading scientists in nanochemistry and optics.

Their paper, Anomalous Fluorescence Enhancement from Double Heterostructure 3D Colloidal Photonic Crystals—A Multifunctional Fluorescence-Based Sensor Platform, is published in the journal *Scientific Reports*.

As well as demonstrating the potential for highly effective performance in ultra-sensitive sensing—with multiple functions including signal enhancement, ease in immobilisation and protection for sensing agents—the research paper presents evidence of significant improvements in energy efficiency and flexibility for lighting devices.

"By using our double heterostructure CPhCs, we can give LEDs a significant increase in energy efficiency and flexibility in colour tuning and colour mixing," says Dr Li.

She adds that in fluorescence-based sensing technologies, improving signal to noise ratio is of paramount significance for improving sensitivity and reliability.

The enormous fluorescence enhancement demonstrated by double heterostructure CPhC will give a significant boost to push the limit.

There are also practical and economic benefits to the Griffith discovery.

"Colloidal photonic crystals can be conveniently made into array systems in mass production fashion, for example by inkjet printing method or by pintool plotter," says Dr Li.

"Both materials and fabrication methods are inexpensive and scalable."

More information: *Scientific Reports*, www.nature.com/articles/srep14439

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