Assessing quantum dot photoemissions

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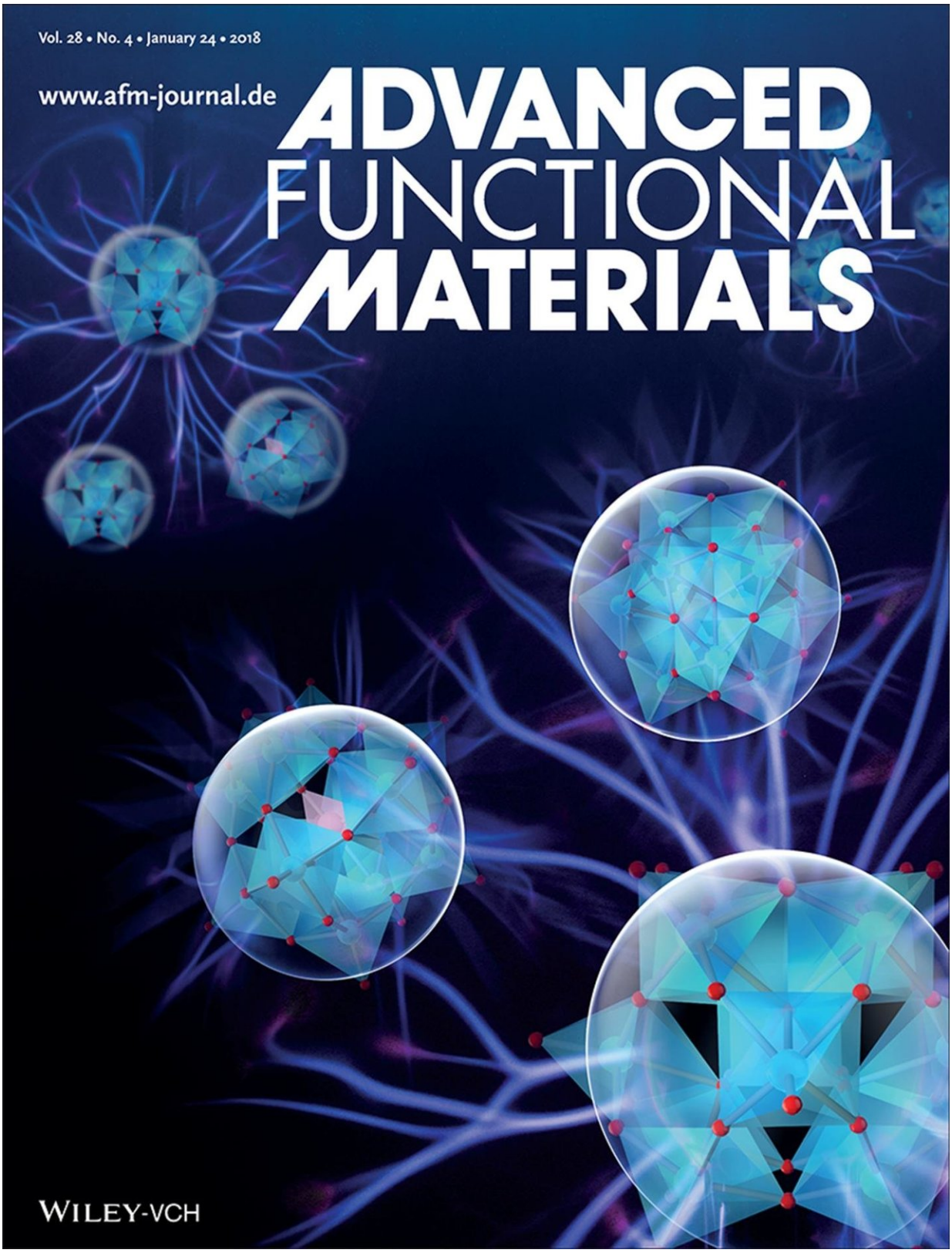

Kumamoto University's Professor Tetsuya Kida and team have shown that

polyoxometalates may be used in a technique to assess quantum dot photoluminescence. Their research is highlighted on the cover of the January 2018 issue of *Advanced Functional Materials*. [Reprinted from Pramata, A. D., Suematsu, K., Quitain, A. T., Sasaki, M., & Kida, T. (2017). Synthesis of Highly Luminescent SnO2 Nanocrystals: Analysis of their Defect-Related Photoluminescence Using Polyoxometalates as Quenchers. *Advanced Functional Materials*, 28(4), 1704620. doi:10.1002/adfm.201704620 with permission from John Wiley and Sons] Credit: Professor Tetsuya Kida

Recent research from Kumamoto University in Japan has revealed that polyoxometalates (POMs), typically used for catalysis, electrochemistry, and photochemistry, may also be used in a technique for analyzing quantum dot (QD) photoluminescence (PL) emission mechanisms.

Quantum dots (QDs) are small, semiconducting nanocrystals or particles typically between two to ten nanometers in size. Discovered almost 40 years ago, their strong photoluminescent properties are a function of their size and shape making them useful for optical applications ranging from bioimaging to light emitting diodes. Advances in high-quality QD research in the last ten years has produced highly luminescent but somewhat unstable QDs that also, unfortunately, use toxic or rare elements. Efforts to create stable QDs without these toxic or expensive elements has been a driving force in recent research.

To address these issues, researchers have been investigating how to change the size, morphology, and PL of tin dioxide (SnO_2) to produce cheap, stable, and nontoxic colloidal semiconductor nanocrystals for various applications. Interestingly, the optical properties of SnO_2 have been found to be effected by defects in both the bulk material and the QDs themselves.

Researchers from Professor Kida's Chemical Engineering Laboratory at

Kumamoto University synthesized SnO_2 QDs using a liquid phase method to produce QDs of various morphologies. The sizes of the QDs were controlled by changing the temperature during synthesis. All of the QDs produced a blue PL when exposed to UV light (370 nm) and QDs 2 nm in size produced the best intensity. To examine the PL properties and mechanisms related to defects in the synthesized QDs, the researchers used materials (POMs) that quench florescence through excited state reactions.

POMs quenched emissions of the SnO_2 QDs at peak intensities (401, 438, and 464 nm) but, to the surprise of the researchers, a previously unseen peak at 410 nm was revealed.

"We believe that the emission at 410 nm is caused by a bulk defect, which cannot be covered by POMs, that causes what is known as radiative recombination—the spontaneous emission of a photon with a wavelength related to the released energy," said project leader Professor Tetsuya Kida. "This work has shown that our technique is effective in analyzing PL emission mechanisms for QDs. We believe it will be highly beneficial for future QD research."

More information: Azzah Dyah Pramata et al, Synthesis of Highly Luminescent SnO2 Nanocrystals: Analysis of their Defect-Related Photoluminescence Using Polyoxometalates as Quenchers, *Advanced Functional Materials* (2017). DOI: 10.1002/adfm.201704620

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