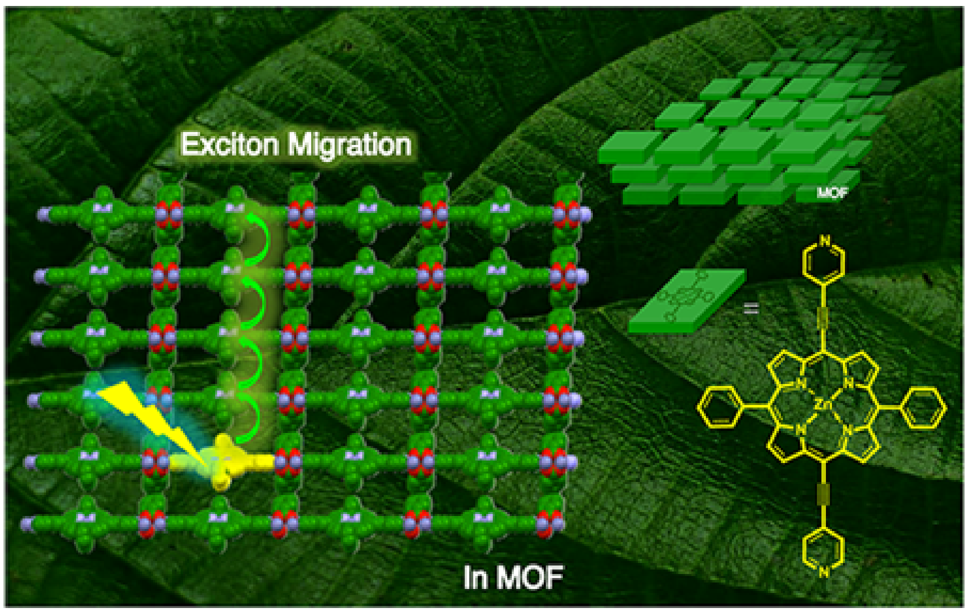
Enhanced light-harvesting in quantum dot-metal-organic frameworks

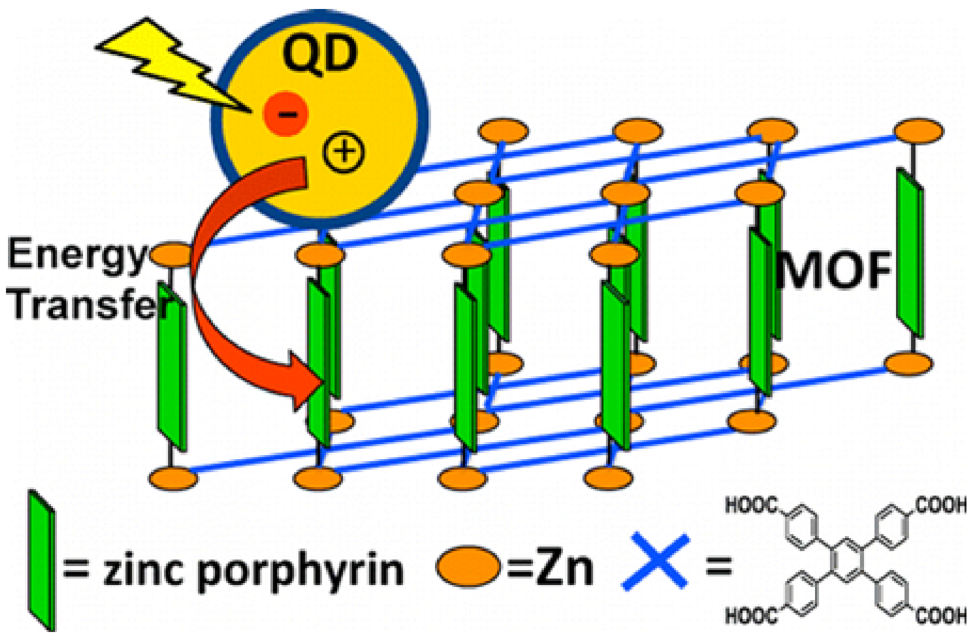
February 26 2013



A schematic of directional energy (exciton) migration in the MOF, along with the porphyrin building-blocks of the MOF, is shown.

Center for Nanoscale Materials (CNM) users from Northwestern University, working together with the Nanophotonics Group at the Argonne National Laboratory, report the functionalization of porphyrin-based metal-organic frameworks (MOFs) with CdSe/ZnS core/shell quantum dots (QDs) for the enhancement of light harvesting via energy transfer from the QDs to the MOFs. This work paves the road for the development of efficient light harvesting complexes for solar energy conversion.

Because of their efficient energy-transport properties, porphyrin-based MOFs are attractive compounds for solar photochemistry applications. However, their absorption bands provide limited coverage in the visible spectral range for light-harvesting applications. The broad absorption band of the QDs in the visible region offers greater coverage of the solar spectrum by QD-MOF hybrid structures. Time-resolved emission studies at CNM show that photoexcitation of the QDs is followed by energy transfer to the MOFs with efficiencies of more than 80%.



Schematic of QD sensitization and energy transfer to the MOFs; QDs are 5-6 nm and the interporphyrin spacing is about 1 nm.

This sensitization approach can result in a >50% increase in the number of photons harvested by a single monolayer MOF structure with a monolayer of QDs on the MOF surface. Porphyrin molecules with different substituents were used to alter the degree of structural anisotropy in the MOF, in order to preferentially increase the anisotropy in electronic coupling between porphyrins in specific directions, so as to produce anisotropic energy migration. Theoretical evaluation of the coupling constants also was performed.

More information: S. Jin et al., Energy Transfer from Quantum Dots to Metal-Organic Frameworks for Enhanced Light Harvesting, *J. Am. Chem. Soc*. 135, 955 (2013).

H.-J. Son et al., Light Harvesting and Ultrafast Energy Migration in Porphyrin-Based Metal-Organic Frameworks, *J. Am. Chem. Soc*. 135, 862 (2013).

Provided by Argonne National Laboratory

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