Molecular switching with single upconverting nanocrystals

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We will discuss two sets of experiments focused on optical manipulation of DTE-py2 photochromic molecules that feature two photocyclization states: ON (fluorescent) and OFF (non-fluorescent).

The first class of experiments will focus on inducing the photochromic reaction of DTE-py2 molecules via infrared excitation of $NaYF_4:Er^{3+}/Yb^{3+}$ up-conversion nanoparticles. The results show that we can switch DTE-py2 molecules from OFF to ON state by exciting a single $NaYF_4:Er^{3+}/Yb^{3+}$ nanoparticle with 980 nm wavelength and observe emission in the visible range. The processes that take place in such a structure can be further enhanced by incorporation of silver nanowires.

The functionality of silver nanowires associated with the ability to transfer energy along the wires via surface plasmon polaritons, provides a way to remotely control the state of the photochromic molecules. Up to 5 photoswitching events have been observed for such an assembly, where a microdroplet of DTE-py2 molecules was precisely deposited on one end of the nanowire.

The nanowires themselves can also be used for modifying the efficiency of the photochromic reaction, the DTE-py2 molecules. In this case, plasmonic excitations in silver nanowires lead to increased photoswitching upon excitation with wavelengths matching the resonance band. In addition, fluorescence intensity of DTE-py2 molecules is enhanced due to coupling with the nanowires.

The results of comprehensive fluorescence microscopy studies carried out on several experimental architectures involving DTE-py2 photochromic molecules indicate that it is possible to control the spectral dependence of photoswitching dynamics and the efficiency of this process through assembly of plasmonically active or near-infrared active up-converting molecular hybrid nanostructures.

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