Physikalisches Institut
Fakultät für Mathematik und Physik
Albert-Ludwigs-Universität Freiburg

QE

Quantum Efficiency Seminar und Colloquium

STANISLAV BALUCHEV

Max-Planck-Institut für Polymerforschung, Mainz

Non-coherent Annihilation Upconversion in Multicomponent Organic Systems: Experimental Sunlight Engineering

To enhance the spectral power density of the VIS-part of the solar spectrum using as energy pool the IR-A part has been a challenge for many research and development groups. The examples of photon energy upconversion (UC) such as simultaneous or sequential absorption of two or more photons with lower energy, second and higher harmonic generation of the fundamental wavelength as well, as parametric processes has been commonly associated with the use of very high excitation intensities (in order of MWcm-2 up to GWcm-2). Additionally, except the process of sequential absorption of two or more photons all other processes ultimately require excitation by coherent light sources (lasers).

In the context of sunlight photonics, the UC-systems based on rare-earth (RE) doped phosphors deserve special attention: efficient UC was demonstrated under low excitation density (Wcm-2). Nevertheless all RE-based UC-systems have a common drawback − the spectral power density of the excitation source must be extremely high (~ Wnm-1).

Up to now the triplet-triplet annihilation-supported upconversion (TTA – UC) is the only upconversion process excited with moderate concentrated sunlight.

Our group demonstrates non-coherently excited UC-systems based on family of symmetrical tetraaryltetraanthra[2,3]porphyrins sensitizers, bearing various substituents in meso-phenyls and anthracene residues. This UC-molecular system efficiently transforms the IR-A part of the sun spectrum into the VIS-range, operating under moderate concentrated sunlight (14 suns, AM1.5). Despite extremely low excitation intensity and spin forbidden transitions, the TTA – UC works in the so called “strong signal” regime, where the concentration of the emitter molecules in excited triplet state is comparable with the total concentration of the emitter molecules. Unique features of the TTA – UC process is the strong dependence of the UC-efficiency on the local mobility of the participating molecules, simultaneously bearing experimental proofs for the existence of long-range interaction force, accountable for the observed phenomena.

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Contact: Andreas Buchleitner, Institute of Physics, Quantum Optics and Statistics
T +49 761 203 5821 F +49 761 203 5967 E buchleitner_office@physik.uni-freiburg.de
www.physik.uni-freiburg.de