Delayed fluorescence from single-wall carbon nanotube-polymer conjugates

Florian Spaeth[1], Dominik Stich[1], Daniel Schilling[1], Hannes Kraus[2], Andreas Sperlich[2], Vladimir Dyakonov[2,3] and Tobias Hertel[1]

[1]Institute of Physical and Theoretical Chemistry,
Julius-Maximilian University Würzburg
Am Hubland, 97074 Würzburg, Germany
[2]Institute of Physics,
Julius-Maximilian University Würzburg
Am Hubland, 97074 Würzburg, Germany
[3]Bavarian Center for Applied Energy Research e.V.
Am Hubland, 97074 Würzburg, Germany

Dispersion of single-wall carbon nanotubes (SWNTs) in polyfluorene solutions is a convenient route towards nearly monodisperse SWNT samples. Time-correlated single photon counting (TCSPC) experiments of SWNT PL reveal a long-living PL component, which is significantly enhanced in these SWNT-polymer conjugates if compared to surfactant-stabilized SWNTs embedded in gelatin films. For the gelatin embedded SWNTs, the PL decay follows t^{-1} kinetics and is attributed to delayed fluorescence (DF) by triplet-triplet annihilation (TTA). In SWNT-polymer conjugates however, DF scales with $t^{-0.6}$. We suggest that excited state dynamics in polymer conjugate samples are more significantly affected by charge carrier recombination, giving rise to modified power law kinetics.

Optically detected magnetic resonance (ODMR) experiments provide evidence of both triplet excitons and free charge carriers in optically excited SWNTs. Ground state recovery in transient absorption experiments on the 100 ps to 1 ns time scale and transient spectra obtained at a delay time of 4 µs suggest that photo-generated charge carriers in gelatin-embedded SWNTs are most likely trapped, while their mobility in SWNT-polyfluorene conjugates is higher and leads to more frequent carrier recombination.

The possibility of generating long-living and mobile excited states under proper environmental conditions together with their excellent liquid phase processability makes SWNT-polymer conjugates promising candidates for active layers in optoelectronic devices, such as solar cells or photo detectors.