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Photoexcitation dynamics in SWCNT from sub-10 fs to ms

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Photophysics in Single Walled Carbon Nanotubes, SWCNT-PEG, prepared by HiPco embedded PMMA is investigated with cw and pulse photo-excitation. Using ultra-short pulses in the visible and near infrared, with time duration of 7 fs and 20 fs respectively, pump-probe spectroscopy is carried out in SWCNT-PEG films in air at room temperature. Photo-bleaching recovery and photoinduced absorption build-up, upon excitation into the second absorption band, are time resolved providing a time constant of 40 plus/minus 5 fs. This is associated to exciton relaxation within semiconducting NTs, due to Fano-type resonances between localized excitonic levels and the underlying continuum density. Pumping in different regions of the absorption spectrum and probing a broad range of wavelengths, gives a complete description of the phenomenon. After relaxation, the decay of the equilibrated exciton occurs with a broad distribution of time constants, which is consistent with the inhomogeneous broadening of the sample. When using the shortest pulses (sub-10 fs) coherent phonons are clearly detected in the transmission difference traces. A radial breathing mode (RBM) at 250 wavenumber is observed, with dephasing of 1.2 ps. Anharmonic coupling between the RBM mode and the G-mode is detected for the first time in the time domain. Using cw excitation at 2.3 and 1.3 eV we observed photorefractivity in SWCNT-PEG samples, kept in vacuum at low temperature, in close analogy with conjugated polymers. Charges, which are photogenerated in the films, can separate giving rise to local electric fields which in turn induce Stark shift of the excitonic resonance.