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Energy transfer in solar cells made from semiconducting carbon nanotubes studied using 2D White-Light Spectroscopy

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It has recently become possible to purify carbon nanotubes into semiconducting thin films, making their use possible in energy harvesting and optoelectronic devices. Individual carbon nanotubes are well known to have exceptional transport and optical properties, but the properties in bulk materials are unknown. They are essentially a new mesoscale material. In this talk, I will report a method that we have developed, called two-dimensional white light spectroscopy (2D WL), which uses a broadband continuum as both the pump and probe source, enabling us to simultaneously examine a spectral range spanning from 500-1400 nm. The 2D WL spectra resolve energy transfer between all possible combinations of excitonic states in the chirality-selected nanotubes, thereby providing an instantaneous and comprehensive snapshot of the dynamical pathways. We observe exciton hopping, exciton dissociation, and anti-correlated energy levels; all of which have important implications in the development of carbon nanotube electronics and optoelectronics.