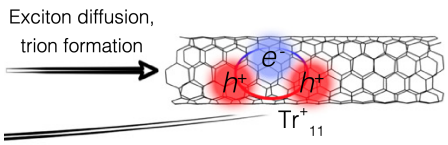

Producing and controlling the density of charged excitations in carbon nanotubes

Value Proposition

Formation of quasiparticles, such as excitons, polarons, and trions in semiconductors are the foundation for modern optoelectronics. The trion, a three-body charge-exciton bound state, offers unique opportunities to simultaneously manipulate charge, spin, and excitation in one-dimensional single-walled carbon nanotubes (SWNTs) at room temperature. Effective exploitation of trion quasi-particles requires fundamental insight into their creation and decay dynamics. Such knowledge, however, remains elusive for single-walled carbon nanotube (SWNT) trion states, due to the electronic and morphological heterogeneity of commonly interrogated SWNT samples, and the fact that transient spectroscopic signals uniquely associated with the trion state have not been identified.

Technology

Duke inventors have reported an optoelectronic system intended for use with SWNT based optoelectronic devices, including photovoltaics, photodetectors, and spintronics. The technology describes length-sorted SWNTs and precisely control charge-carrier-doping densities to determine trion dynamics using femtosecond pump–probe spectroscopy. Identification of the trion transient absorptive hallmark enables us to demonstrate that trions (i) derive from a precursor excitonic state, (ii) are produced via migration of excitons to stationary hole-polaron sites, and (iii) decay in a first-order manner. Importantly, under appropriate carrier-doping densities, exciton-to-trion conversion in SWNTs can approach 100% at ambient temperature.

Advantages

- Provides control of trion density in carbon nanotubes
- The trion offers unique opportunities to simultaneously manipulate charge, spin and excitation in 1D SWNTs at room temperature
- This information can be manipulated for exploiting SWNTs in photon sensing, photovoltaic, and many other optoelectronic applications

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Publication(s)

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External Link(s)

• From the lab of Dr. Michael Therien