Molecular screening effects on trion binding energies and electronic band gaps in air-suspended carbon nanotubes

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The quasi-one-dimensional geometry of single-walled carbon nanotubes results in enhanced Coulombic interactions. The strong electron-hole attractive force leads to a formation of tightly bound excitons and trions. These optical properties are sensitive to environmental screening, which causes the reduction of the Coulombic interactions. For air-suspended nanotubes, the excitons are known to be affected by screening of adsorbed molecules [1,2]. However, the effect of the adsorbed molecules on the trion binding energies and electronic band gaps still remain unclear.

Here, we investigate the molecular screening effects on trion binding energies and electronic band gaps in air-suspended carbon nanotubes within field-effect transistor configuration. Measurements of gate voltage dependence on photoluminescence from nanotubes before and after the molecular adsorption show that the molecules significantly modify the trion binding energies as well as the electronic band gaps. We further observe large influence of the excitation power on the gate dependence of photoluminescence, which could be a signature of the band gap renormalization induced by excitonic screening.

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