Fano Effect on Dynamical Conductivity for Perpendicular Polarization in Double-Wall Carbon Nanotubes

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We study the dynamical conductivity of double-wall carbon nanotubes for perpendicularly polarized light to the tube axis by taking into account screening effects, exciton effects and depolarization effects within an effective-mass theory. For single-wall carbon nanotubes, it is known that the dynamical conductivity for perpendicularly polarized light is reduced considerably by a depolarization effect in comparison with that for parallel polarized light, but exhibits prominent exciton peaks in semiconducting nanotubes due to the strong Coulomb interaction. For double-wall carbon nanotubes, the Coulomb interaction is suppressed by not only intra-wall screening effects but also inter-wall screening effects. This leads to the reduction of exciton binding energies and band gaps; however, clear exciton peaks still survive in the spectra. We also find that the exciton peak of the semiconducting inner tube has an asymmetric line shape due to the coupling with a continuum state of the outer tube, indicating the Fano effect. The Fano coupling strength can be turned by varying the inter-wall distance or tube radius ratio. We discuss both cases of semiconducting and metallic outer tubes.