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Title:Hydrodynamic model for the signal propagation along carbon nanotubes
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Abstract:We formulated a hydrodynamic model in order to describe the dynamical behavior of the Π-electrons in single carbon nanotube shells of arbitrary chirality, either metallic or semiconducting, below terahertz frequencies, as long as only intraband transitions of the Π-electrons are allowed. The hydrodynamic equations were derived in a self-consistent way from the semiclassical Boltzmann equation. The electron fluid was taken to comprise many electron species, each characterized by a different effective mass, which takes into account the interaction with the nanotube ion lattice. A linear transport model for the Π-electrons was derived from the hydrodynamic equations. A transmission line model was eventually formulated to describe the propagation of an electric signal along a single-wall carbon nanotube of arbitrary chirality. The transport model formulated can be also used for analyzing electromagnetic propagation in complex structures composed of single carbon-nanotube shells with different chirality, such as bundles of single wall carbon nanotubes and multi-wall carbon nanotubes, provided that the tunneling between adjacent shells may be disregarded.
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