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Electrodynamics of Multiwall Carbon Nanotubes with Intershell Tunneling

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Carbon nanotubes (CNTs) (e.g.,[1]) can be used as possible alternative to metals like copper andaluminum to fabricate interconnects and antennas. The typical diameter of SWCNTs is about 1 nm and, depending on its chirality's, can be either metallic or semiconductor. On the other hand MWCNTs have diameters in a wide range of a few to hundreds of nanometers and are composed of both metallic and semiconducting CNT shells. The electromagnetic behavior of MWCNTs, in the low frequency regime where only intraband transitions are allowed, depend on the number of effective conducting channels of each shell [2], the electron tunneling between adjacent shells [3] and the electromagnetic interaction between shells and environment. In [4] a transmission line model has been proposed to account for the intershell tunneling on the propagation of electric signals. The intershell tunneling qualitatively change the form of the standard transmission line equations through the tunneling inductance and capacitance operators, which have to be added to the kinetic and magnetic inductance matrices and to the quantum and electrical capacitance matrices. The tunneling inductance operator is responsible of a strong spatial dispersion and coupling between the lines.
Since in [4] the effects of the tunneling transverse currents have been disregarded the transmission line model is only valid in the frequency range from microwave up to terahertz. In this paper we remove this limitation by accounting for the effects of the tunneling transverse currents and obtain a model that is valid from dc up to terahertz frequencies. The description of the tunneling ransverse currents is carried on the basis of the density matrix formalism and Liouville equation [3].

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Plasmon polariton slowing down in graphene structures

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Dispersion of plasmon polariton in few layer graphene is derived and analyzed. It is shown that dispersion properties and electromagnetic wave slowing down in graphene considerably depend on the electron band which conduction electron occupied. The electron tunneling effect between graphene layers is considerable obstacle for strong wave slowing down. There are electron bands in vicinity of graphene Dirac point K with the states which concentrated mainly on dedicated layers. If the level of graphene doping corresponds to occupation of such zones by conduction electron then tunneling effect is suppressed. This gives possibility to strong wave slowing down and Cherenkov synchronism of plasmon polariton with nonrelativistic electron beam.

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