

Understanding high frequency transport in low-dimensional graphitic carbon and superlattice systems

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Developing hybrid super-structures including carbon nanostructures for quantum information science is widely sought after and we show a possible route in carbon superlattice structures based on experimental results as well as theoretical analysis which also incorporates high-speed switching capabilities. We propose a theoretical model of disordered carbon superlattice structures where the local density of electronic states is controlled by changing the sp^3 -C bond alternation as well as the hopping disorder parameter of the sp^2 -C regions [1]. In addition the incorporation of nitrogen atoms in carbon networks was modeled as a combination of disorders which vary both in correlated and uncorrelated manners. Resonant peaks associated with C and N sites in these structures show a conductance cross-over under variation of the nitrogen concentration in these structures which can explain the observed negative differential resistance in diamond-like carbon superlattices as well as the conductivity cross-over in nano-crystalline diamond films [2], [3]. Detailed analysis of transport measurements over a wide range of temperatures, magnetic fields and also frequency shows an enhanced characteristic length in these systems that supports switching of complex impedance in the range of 65 GHz. High frequency transport properties of carbon superlattice structures are compared to carbon nanotube and graphene devices which can demonstrate ballistic conductance features.

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