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Enhanced tunnel transport in disordered carbon superlattice structures incorporated with nitrogen

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Abstract content
   (Max 300 words)

The possibility for enhanced tunnel transport through incorporating nitrogen in a superstructure of amorphous carbon (a-C) made of spˆ2-C and spˆ3-C phases is shown by using a tight-binding model. The proposed quasi-one dimensional superlattice structure can be described by a set of graphitic clusters (acting as quantum wells) separated by diamond-like carbon (barriers) where the variation of the width and depth of carbon clusters significantly control the electron transmission peaks. A large structural disorder in the pure carbon system, introduced through the variation of the bond length and associated deformation potential for respective carbon phases, was found to suppress the sharp features of the transmission coefficients. A small percentage of nitrogen addition to the carbon clusters can produce a distinct peak at low energy; however, it can be practically depleted due to increase of the level of disorder of carbon sites. We demonstrate, by controlling the arrangement of the nitrogen sites of increased concentration within the spˆ2-C clusters, pronounced resonance peaks both at high and low energy levels. This study shows that nitrogen atoms forming a deep donor level (or band) in carbon structure can still contribute to the improvement of the tunnel transport features in a-CN films. However, the effect of disorder is more important than that of nitrogen itself, treated as shallow or deep donor levels which control the transport of the system most effectively. We studied the effect of disorder created by nitrogen incorporation in carbon multi-layers, which depletes the resonant tunneling effects. The interplay of disorder associated with N and C sites showed the tunable nature of resistance of the structures and established resonant tunneling transport of electrons within these C-N structures.

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