Atomic-scale observation of ballistic electron transport in single layer Graphene

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Abstract

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The Scanning Tunneling Microscope is an ideal technique for probing the electronic properties of graphene at the atomic scale. Here, we present recent STM manipulation experiments on epitaxial graphene and the carbon-rich buffer layer grown on the SiC(0001) surface [1]. Low voltage pulses from the STM tip (±4 V) applied to the graphene layer induce modifications of a bare C-rich region several nanometers away. The graphene layer itself is not affected. This non local manipulation operates up to a maximum distance of about 10 nm providing direct evidence for ballistic hot electrons propagating along the graphene layer to the graphene edge. This is an experimental observation at the atomic scale of ballistic electron propagation in graphene which had been predicted previously in theory calculations [2]. While inelastic electron-phonon scattering limits the propagation length to about 10 nm as predicted, the relatively high energy of the electrons used in this experiment indicates that high lying energy states of the graphene (van Hove) could explain both the propagation through the graphene and the coupling to the adjacent C-rich layer. In addition, preferred directions are observed in the ballistic electron propagation. This could be explained by the localization of the surface electrons on the graphene lattice as has been observed in the formation of quantum interferences at graphene step edges [3].

References

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