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Band Gap Opening in Periodically Modified Graphene MARC DVORAK, ZHIGANG WU, Department of Physics, Colorado School of Mines — The gapless electronic structure of graphene must be modified to allow a meaningful on-and-off ratio for use in field-effect transistors. Many attempts to create semiconducting graphene have been made; among them, application of periodic structural modifications, such as patterned defects or nanoscale perforation creating a graphene nanomesh, is particularly promising. Extensive theoretical efforts have been spent to investigate such graphene structures, but the precise role of periodic perturbation on band gap opening remains unclear. Here, we show analytically that band gap opening in graphene under a periodic perturbation can be accurately predicted by mapping the perturbative reciprocal lattice vectors onto Dirac points. The modified graphene alternates between a semi-metal and a semiconductor with 8/9 gapless and 1/9 semiconducting. Furthermore, semiconducting modified graphene can be mapped to exactly two corresponding semimetallic carbon nanotubes or graphene nanoribbons. These predictions reveal the fundamental physics of band gap opening in periodically defected graphene and are in excellent agreement with previous and present first-principles results for graphene nanomeshes.

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