Rectifying effect in high-performance ballistic diode bridge with a unique design for thermal energy harvesting

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Abstract

The long mean free path close to a micrometer in encapsulated graphene enabled us to rectify currents ballistically at room temperature. In this study, we introduce a ballistic rectifier that resembles a diode bridge and is based on graphene encapsulated using hexagonal boron nitride. Our device's asymmetric geometry combined with the exploitation of the ratcheting effect means that it can operate successfully and provides excellent performance. The device's estimated responsivities at 38,000 V/W for holes and 23,000 V/W for electrons at room temperature, are among the highest values for a ballistic device reported to date. Due to the device's zero threshold voltage, it is able to rectify Johnson noise signals converting thermal excitation to electrical energy at room temperature. The bandwidth of the device at the ballistic regime is estimated at ~ 1.1 GHz for holes and 2 GHz for electrons. The device developed in this study is an important step along an innovative pathway that will lead to harvesting electrical energy directly from thermal energy.

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