Fabrication and characterization of metal-insulator-graphene diodes for microwave and THz application

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Vertical devices based on two-dimensional materials have opened up new opportunities for pushing the limits of the state-of-the-art in electronics and photonics. Here we report on the fabrication and characterization of vertical metal-insulator-graphene (MIG) diodes using 6 nm TiO_2 as barrier material and Ti as metal. The current-voltage characteristic of the MIG diode is highly nonlinear and asymmetric and can be well explained by thermal emission theory using an energy barrier of 450 meV for the electrons in the graphene. The fabricated MIG diodes show an asymmetry of 570, a nonlinearity of 9.9 and a maximum responsivity of 28 V^{-1}. These values are outperforming the values of corresponding metal-insulator-metal diodes and provide excellent prospects for applications in microwave and THz rectification, mixing, frequency conversion, and detection.

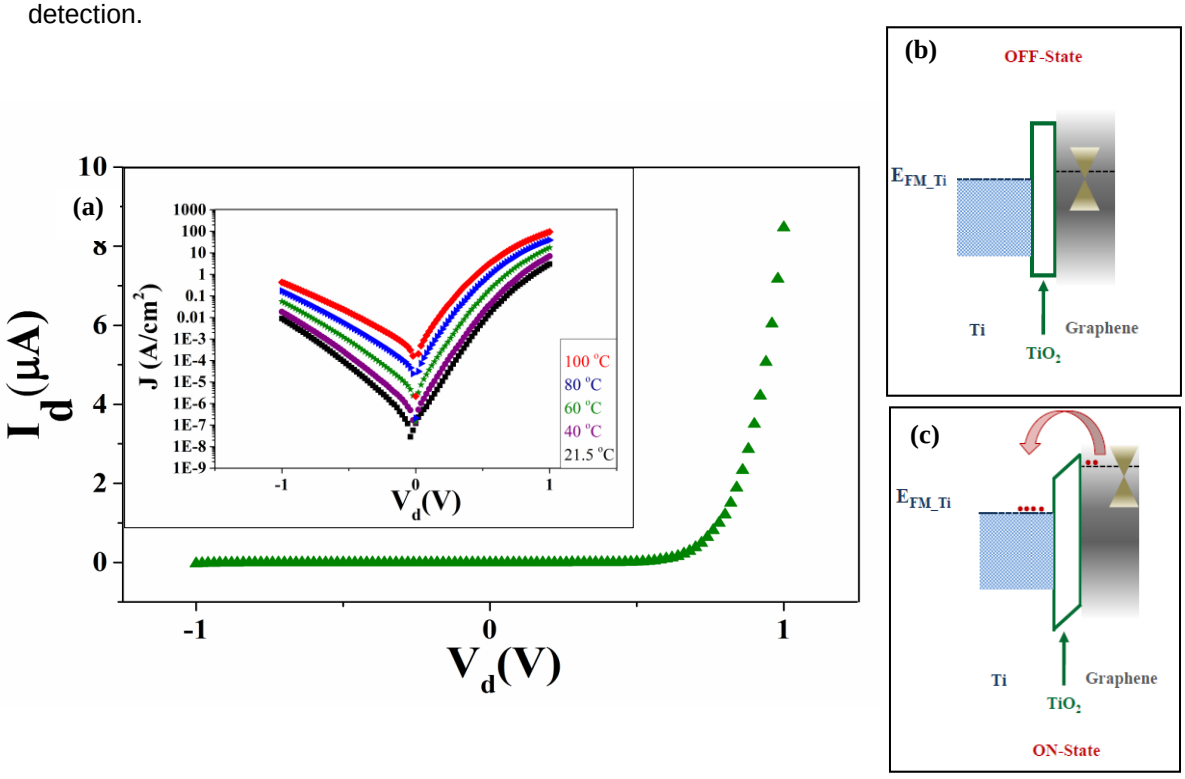

Fig. 1.(a) Room-temperature current-density-voltage characterization of the device. Inset: Plot of temperature dependence of current density versus voltage; Band diagram for the vertical graphene diode in OFF-state (b) and ON state (c).