One-Dimensional Metal-Insulator-Graphene Diode

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Diodes are key components for radio frequency (RF) and THz electronic devices. Currently semiconductor p-n junction based diodes and Schottky junction diodes are dominating RF applications, because of their excellent non-linear characteristic, well controlled processing technology and relatively high RF bandwidth. In recent years, there was a growing interest in metal-insulator-metal (MIM) diodes [1] and more recently also in metal-insulator-graphene (MIG) diodes [2], because these diodes can be fabricated in a thin-film process [3,4]. The main drawback of MIM/MIG diodes is currently the large device capacitance limiting the RF bandwidth to ~100 GHz. Here we present a novel design for high performance MIG diodes, which reduces significantly the device capacitance enabling operation up to several THz. The device geometry is illustrated in Figure 1, where the capacitance is formed by a 1D line. The 1D MIG diode is based on an encapsulated graphene stack. A thin TiO_2 barrier layer material forms the diode junction, and the charge carriers transport in this device takes place laterally. Compared to the state-of-the-art, the geometry capacitance is largely reduced. Besides, the current density in the geometry is much higher and values up to 10^7 A/cm² have been measured. These two advantages make the proposed lateral 1D MIG diode significantly outperforming conventional MIM and MIG diodes and also a very promising candidate for future RF, THz and energy harvesting applications based on thin-film technology.

References

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Figures

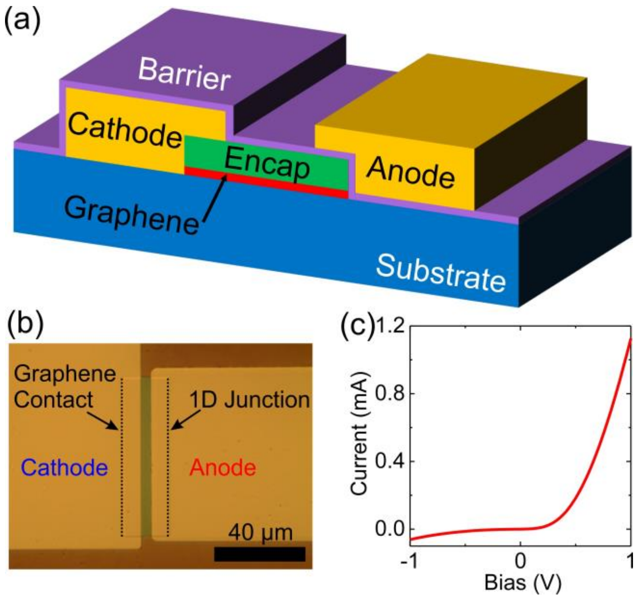

Figure 1: Schematic layout of the 1D-MIG diode (a) optical micrograph of a fabricated device (b), and the measured I-V characteristics (c).