Vertically stacked graphene tunneling junction with insulative water layer

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1. Introduction

Graphene fabrication progress based on heterostructures has attracted considerable interest in novel functional devices, such as tunneling diode consisted of vertically stacked graphene [1]. Recently, atomically thin insulated materials such as boron nitride and the transition metal dichalcogenides were utilized for tunneling barrier. Here we report a new type of vertically stacked graphene tunneling junction structure which adopted water layers grown on epitaxial graphene as tunneling barrier.

2. Experiment

Two samples (10 mm x 10 mm) of the epitaxial graphene on SiC substrates were fabricated by using an infrared rapid thermal annealer (SR-1800). Single-crystal graphene samples were subjected to ion etching for patterning. One graphene sample was treated with deionized water (DI) for 15 mins. After DI treatment, graphene surface was covered with atomically thin structured water layer [2]. For making a diode structure, the samples were stacked each other as shown in Fig. 1. I-V characteristics were measured using two contact probes on the graphene surface.

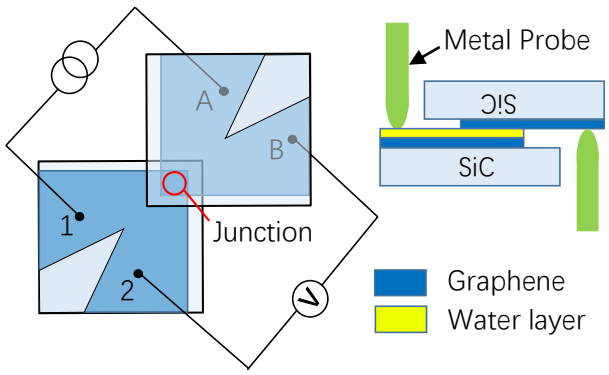

Fig 1. Schematic of stacked graphene diode

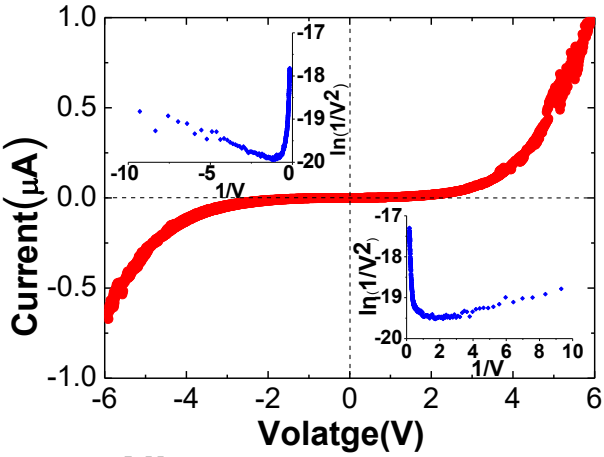

Fig 2. I-V characteristics of tunneling junction

3. Results

Fig. 2 shows diode characteristics of the stacked graphene device. A strong non-linear characteristic was observed and the resistance of zero bias voltage was around $10^8\,\Omega$. In the Fowler-Nordheim (FN) plots (insets of Fig. 2) of our stacked graphene diode, both FN tunneling and direct tunneling phenomena are observed. Our findings lead us to conclude that the water layer tunneling barriers could demonstrate the tunneling characteristics of the vertically stacked graphene diode.

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[1] L. Britnell et al., Nat. Commun. 4, 1794(2013).
[2] M. Kitaoka, et al., Jpn. J. Appl. Phys. 56, 085102 (2017).