Ultraviolet Light Induced Electrical Hysteresis Effect in Graphene-GaN Heterojunction

Nagoya Inst. of Tech., ◦Ajinkya K. Ranade(D), Rakesh Mahyavanshi, Pradeep Desai, Masaki Tanemura, Golap Kalita

E-mail: ajinkyaranade3@gmail.com

Introduction: Fabrication of a two/three-dimensional (2D/3D) heterojunction device has attracted significant attention to develop high performance photodiodes, light emitting diodes, solar cells and other electronic devices. The Schottky junction devices are very sensitive to the interface properties of metal and semiconductors. Here, we reveal the effect of interface trap sites under the ultraviolet (UV) illumination in a graphene/gallium nitride (GaN) vertical heterojunction Schottky device.

Experimental: A chemical vapor deposited graphene film was transferred on a free-standing n-type GaN substrate for the Schottky diode fabrication. Further, Au and In electrodes were deposited on graphene and GaN respectively using thermal evaporator under high vacuum condition. The device properties were analyzed by current density-voltage (J-V) measurements using two-probe system and a Keithley 2401 Source Meter.

Results and discussion: Figure 1a-b shows the J-V characteristics under dark and ultraviolet (UV) illumination. A Schottky junction characteristics was obtained with low reverse saturation current and high turn-on voltage (~1V). The J-V characteristics of the device were also measured in forward and reverse sweeps to analyze the electrical hysteresis behavior. The electrical hysteresis is quite evident with UV illumination. Again, a fabricated graphene/GaN Schottky device free from electrical hysteresis in no illumination condition (dark), showed hysteresis with the illumination of UV light. The residual impurities of graphene and surface defects of GaN act as trap sites for the photocarriers as shown in figure 1c, as a result interface dependent photoresponsivity are observed.

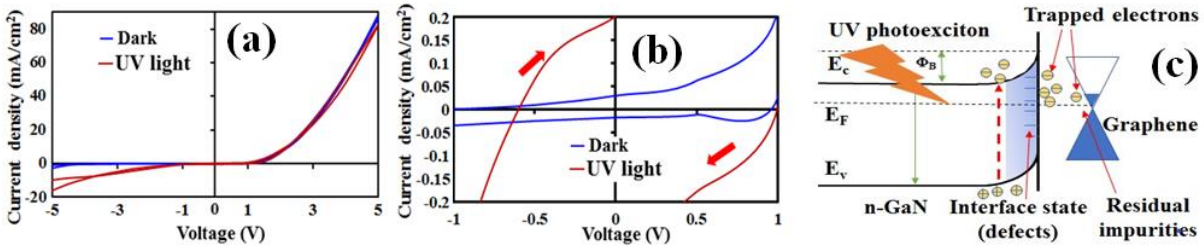

Figure 1 (a) J-V Characteristics for bias voltage -5 to 5V and (b) lower bias voltage (-1 to 1V) for graphene-GaN heterostructure showing hysteresis behavior. (c) Band diagram of n-GaN/graphene heterostructure depicting probable hysteresis phenomenon.

Reference: G. Kalita, M. D. Shaarin, B. Paudel, R. Mahyavanshi, M. Tanemura, Appl. Phys. Lett. 2017, 111, 013504.