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July 11^{th}, 2017 10:30, LPICM 408

Nitrided and Fluorinated Graphene for the Applications on High Mobility Graphene Transistor, Memory and Chemical Sensor

Abstract:
A novel graphene based insulator, fluorographene, is firstly applied as gate dielectric in a field effect transistor. To identify the dielectric quality, dielectric constant, breakdown electric field and thermal stability are investigated. In this talk, the scalable and one-step fabrication of single atomic-layer transistors is demonstrated by the selective fluorination of graphene using a low-damage CF4 plasma treatment, where the generated F-radicals preferentially fluorinated the graphene at low temperature (<200 °C) while defect formation was suppressed by screening out the effect of ion damage. The fluorographe was also used as decoupling for graphene as its substrate and mobility was improved much. Graphene nanodiscs (GNDs), functionalized using NH3 plasma, as charge trapping sites (CTSs) for non-volatile memory applications have been investigated. The fabrication process relies on the patterning of Au nanoparticles (Au-NPs), whose thicknesses are tuned to adjust the GND density and size upon etching. A GND density as high as 8×10^{11} cm^{-2} and a diameter of approximately 20 nm are achieved. The functionalization of GNDs by NH3 plasma creates NH^+ functional groups that act as CTSs, as observed by Raman and Fourier transform infrared spectroscopy. This inherently enhances the density of CTSs in the GNDs, as a result, the charge loss is less than 10% for a 10-year data retention testing, making this low-temperature process suitable for low-cost non-volatile memory applications on flexible substrates. Moreover, the pH, pNa ion sensing properties of graphene based ion-sensor by nickel end contact modification were demonstrated. The pH and pNa sensitivities were around 36.5mV/pH and 15.3mV/pNa, respectively, for pristine graphene. For Ni end-contact modified graphene, sensitivities are changed to 41mV/pH and no pNa sensitivity.

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