Novel Pattern Graphene Fabrication Methods And Their Application in Graphene Based Nano-Optoelectronic Devices

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A promising site-controllable patterned graphene transfer method, which can economize graphene material and requires no additional etching process, was developed.

A simple and scalable graphene patterning method was also invented, which employed electron-beam or ultraviolet lithography followed by a lift-off process. This method, with the merits of: high pattern resolution and high alignment accuracy, without additional harsh process, universal to arbitrary substrates, compatible to Si microelectronic technology, can be easily applied to array-based device applications.

Based on the above approaches, various graphene / semiconductor nanowire hybrid optoelectronic devices were fabricated, including high-performance graphene / CdS semiconductor nanowire (SNW) Schottky junction solar cells and novel graphene nanoribbon (GNR)/ SNW heterojunction light-emitting diodes (LEDs). In former work, Au (5 nm)/graphene composite electrode was used as the Schottky contact electrode to the NW. Typical as-fabricated solar cells showed excellent photovoltaic behavior with an energy conversion efficiency up to ~1.65%. In latter work, ZnO, CdS, and CdSe NWs were employed as representatives. At forward biases, the GNR/SNW heterjunction LEDs could emit light with wavelengths varying from ultraviolet (380 nm) to green (513 nm) to red (705 nm), which were determined by the band-gaps of the involved SNWs. The mechanism of light emitting for the GNR/SNW heterojunction LEDs was discussed. Our work pioneers new routes to developing diverse graphene-based nano-optoelectronic devices, which are basic components in integrated optoelectronic system.

References


Figures
Figure caption

Figure 1. The method to transfer a patterned graphene to desired position on a device substrate.

Figure 2. A simple and scalable graphene patterning method is invented (Patent No. 201010215355.4):

Figure 3. (a)-(c) The optical images of the GNR/SNW (ZnO, CdS, CdSe, respectively) heterojunction LEDs at a forward bias of 5 V. (d)-(f). Room-temperature EL spectra for GNR/SNW (ZnO, CdS, CdSe, respectively) heterojunction LEDs at various forward biases.