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Gate-tunable Schottky junction solar cells with light transparent and electric-field permeable graphene mesh on n-Si

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Schottky junction solar cells (SJSCs) that utilize a built-in potential across metal-semiconductors or metal-insulator-semiconductors have an advantage over standard p-n junction solar cells in that complementary doping is not indispensable for a Schottky junction. Recently, the SJSCs made with graphene electrodes, intended to replace vacuum-evaporated metal grids, have attracted interest due to their high power conversion efficiency (PCE), simple structure and easy fabrication process. Graphene is advantageous over normal metal grids, in that the optically active built-in potential can be developed over regions just beneath the graphene. Despite of the rapid enhancement in power conversion efficiency (PCE) of graphene-on-silicon Schottky junction solar cells (Gr-Si SJSCs), it is still lower than the best record for Au/Si Schottky junction solar cells, indicating that there remains lots of room for improvement. Herein, we introduce a new approach for modulating the interface potential of the SJSCs by applying an external gate voltage (Vg) to the Gr-Si SJSCs for improving the efficiency. Specially, by replacing the graphene with graphene mesh, we have demonstrated: (1) higher PCE values at Vg in the range of 0V to -1V; and (2) more rapid enhancement of PCE values with varied Vg (from 7.9% to 11.2%). We further found that the PEC values were hardly saturated and increased continuously until Vg=-1 V. This result illustrates that the PCE can be further improved by introducing dielectric materials with higher dielectric strength. This approach, which exploits the light transparent and electric-field permeable electrodes, would be applicable to many types of energy-conversion devices. Moreover, this work provides new opportunities to reach the maximum theoretical efficiency limits, such as the Shockley-Queisser limit of solar cells.

Biography

Won Il Park is an Associate Professor in Material Science and Engineering, Hanyang University. He received his PhD degree in Material Sciences and Engineering from POSTECH in 2005, and joined Liber group of Harvard University as a Post-doctoral Fellow from 2005 to 2007. His present research interests are synthesis and characterization of semiconductor nanostructures such as nanowires, nanorods and 2D materials, and development of nanoscale photonic and electronic devices.

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