

Title: High-performance photodetectors based on low-dimensional semiconductor nanostructures

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As one of the most important optoelectronic devices, nanoscale photodetectors particularly for those used in ultraviolet (UV) detection manifest extensive applications in UV astronomy, space communications, environmental, biological research, and so on. However, the device performance of present nanoscale photodetectors, such as photoresponsivity and response time, still requires further improvment even though extensive efforts have been made in the past years. Herein, we report three means to enhance the photodetector performance by means of heterostructure construction, crystal defect engineering and surface modification of semiconductor nanostructures. First, we demonstrate the designable synthesis of 3D-branched 3C-SiC/ZnO heterostructures by a three-step process and their assembling into an ultrasensitive photodetector. Optoelectronic tests on the 3C-SiC/ZnO heterostructure photodetector showed the outstanding photo-detection performance which is significantly advantageous or comparable to those of ZnO-based and other inorganic semiconductor nanostructure photodetectors due to the promotion of the photogenerated electron collections and the transport efficiency based on the energy band-gap model. Second, we report the bicrystalline GaN nanowires via Au catalyzed CVD method and used them to fabricate the high performance UV photodetectors, which shows a high wavelength selectivity, an ultrahigh photoresponsivity of 1.74×10^7 A/W and EQE of 6.08×10^9%, a sensitivity of 2×10^4%, and a very large on/off ratio of more than two orders, as well as robust photocurrent stability. It is believed that the unique bicrystalline GaN nanowire with two individual crystal GaN domains provides two separated and rapid carrier transfer channels, which significantly boosts the photodetector performance. At last, we illustrate the performance enhancement of individual GaN nanowire UV detectors through the modification of Pt nanoparticles. The results suggest that localized surface plasmon resonance, hot electron injection, enhanced incident light scattering and surface depletion region induced by Pt nanoparticle decoration can drastically improve the responsivity, EQE, sensitivity and response time of the GaN nanowire UV photodetectors. All the results prove that the strategies proposed in these work are effective toward the fabrication of high-performance optoelectronic nanosensors.

Biography

Xinglai Zhang has completed his PhD at the age of 30 years from Pusan National University and postdoctoral studies from Institute of Metal Research (IMR), Chinese Academy of Sciences (CAS). Now, he is the assitant profesor of IMR, CAS. He has published more than 20 papers in reputed journals. His research interests are focused on the growth design of low-dimensional nanomaterials and optoelectronics devices development.

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