Hierarchical ZnO Nanowire Arrays on Si Honeycomb Structures for Flexible and Omnidirectional Photodetectors

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The development of photon management techniques is a key issue for high performance of optoelectronics including photodetectors, light-emitting diodes, and solar cells. In order to effectively collect omnidirectional light, low-refractive index antireflection coating[1] or antireflective nanostructures such as nanodome[2] and inverted nanocone[3] are introduced onto the surface of optoelectronics. Beside, hierarchically designed micro/nanostructures can enhance the light absorption efficiency via efficient light absorption and management behavior[4].

In this study, we develop an omnidirectional UV/Visible photodetector which has a broad absorption spectral range of 380 to 1100 nm based on hierarchical heterostructures of n-type ZnO nanowires (NWs) on honeycomb-structured p-type silicon (H-Si) membranes. Fig. 1(a) shows a schematic for our flexible photodetectors of ZnO NWs/H-Si heterostructures, where a free-standing H-Si membrane is attached onto a flexible polyimide substrate. The omnidirectional light absorption of hierarchical nanowire/honeycomb structure is demonstrated by angle-dependent photocurrent variation, as can be shown in Fig. 1(b). Furthermore, the tendency of photocurrent variation is in good agreement with the result of UV-Vis-NIR analysis with variable angle specular reflectance accessory (VASRA). In summary, we suggest hierarchically designed nanowire on honeycomb structures as a new approach for omnidirectional light absorption in flexible optoelectronic system. We anticipate that our unique structure can be utilized to future energy-harvesting system and high-performance flexible electronic industry.

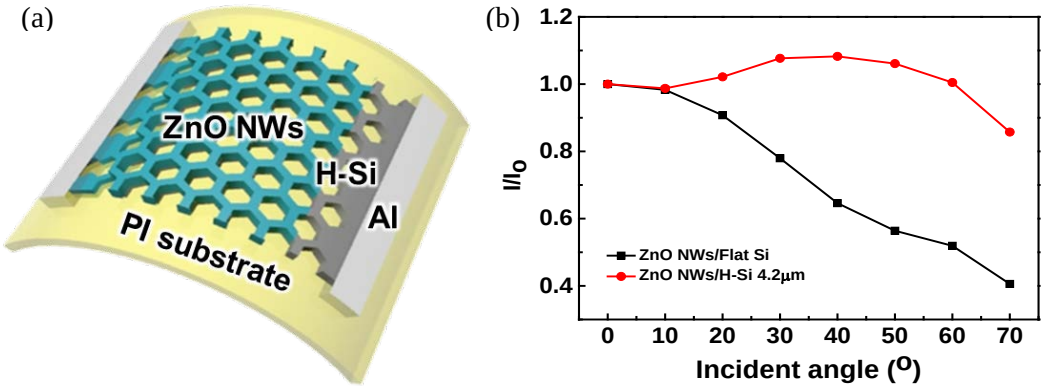

Fig. 1. (a) Schematic for flexible and omnidirectional n-ZnO NWs/p-Si photodetector. (b) Variation of photocurrent depending on the light incident angle with illumination of 650 nm laser.

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