

# The Electrical Characteristics of Aluminum-Doped Zinc Oxide Nanorods and p-Type Silicon Heterojunctions

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## ABSTRACT

In this study, aluminum-doped zinc oxide (Al-doped ZnO) nanorods which were prepared with doping aluminum nitrate ( $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ ) by solution growth method on p-type silicon substrate were fully characterized. First, ethyl alcohol ( $\text{C}_2\text{H}_5\text{OH}$ ) was added to zinc acetate ( $\text{Zn}(\text{CH}_3\text{COO})_2 \cdot 2\text{H}_2\text{O}$ ) to form a 0.0075M mixed solution. This mixed solution was then used to form a seeding layer on silicon substrate by spin coating. Subsequently, mixed solutions using 0.02M hexamethylenetetramine ( $\text{C}_6\text{H}_{12}\text{N}_4$ ), 0.02M zinc nitrate hexahydrate ( $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ ), and aluminum nitrate ( $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ ) of various concentrations were prepared. And the growth was carried out in the mixed solution at 90°C for two hours. As observed from field-emission scanning electron microscope (FE-SEM), the synthesized ZnO are hexagonal nanorods indeed. The chemical components of Al-doped ZnO nanorods were determined from energy diffraction spectroscopy (EDS) and are zinc, oxygen, and aluminum. The conductivity type for Al-doped ZnO nanorods is n-type indeed as was determined from Hall effect measurement, and the conductivity has been increased substantially by aluminum nitrate concentration; while mobility for majority carrier decreases with aluminum nitrate. As expected, the Al-doped ZnO nanorods prepared by aluminum nitrate of different concentrations also exhibit different I-V characteristics. In addition, the photoluminescence (PL) characteristic peak is in the range between 376.1nm and 379.4nm for Al-doped ZnO nanorods. Lastly, Al-doped ZnO nanorods were fabricated on a p-type silicon substrate to form a n-ZnO/p-Si heterojunction. This n-ZnO/p-Si heterojunction exhibits rectifying characteristics and its parameters such as reverse saturation current and ideality factor have been successfully determined.

Keywords : aluminum-doped zinc oxide (Al-doped ZnO)、Hall effect measurement、photoluminescence (PL)、n-ZnO/p-Si heterojunction

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