

## Surface Charge Effects of ZnO Nanorods Growth

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We investigated the influences of charges near the substrate surfaces on vertically aligned ZnO nanorod growth. ZnO nanorods were fabricated on Al<sub>2</sub>O<sub>3</sub> and n-GaN substrates by a catalyst-free Metal Organic Chemical Vapor Deposition (MOCVD). H<sup>+</sup> ions with total flux of 10<sup>16</sup>cm<sup>-2</sup> and 10<sup>17</sup>cm<sup>-2</sup> were directly implanted on Al<sub>2</sub>O<sub>3</sub> and n-GaN substrates and subsequently, ZnO was deposited on the ion-implanted substrates *ex-situ*. The ion energy was 120 keV. From field emission transmission electron microscope measurements we could confirm that H<sup>+</sup> ions mostly existed in the depth around 570 nm and 300 nm from the surfaces of Al<sub>2</sub>O<sub>3</sub> and n-GaN, respectively. In spite of the ion implantation, the surface damage was negligible. The ZnO deposited on the substrates were amorphous films or formed into low-quality nanorods. Since the ZnO nanorods are well-grown on untouched Al<sub>2</sub>O<sub>3</sub> and n-GaN substrates, we concluded that the external surface + charges prevent ZnO forming into high-quality nanorods. Our observation strongly suggested that the surface charge is one of the important factors to contribute to the ZnO nanorod growth, and that for the high quality ZnO nanorod growth, Zn<sup>2+</sup> atoms should bond first with the substrate surface.