Pattern-Controlled Vertical and Lateral Growth of ZnO Nanorod Arrays for High Performance Transistors and Biosensors

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ABSTRACT

One dimensional zinc oxide (ZnO) nanostructures are one of most attractive compound semiconductors due to its specific characteristics such as wide band gap, large exciton binding energy, biocompatibility, piezoelectricity, etc. Especially ZnO nanowires (or nanorods) have a great diversity of application in electronics, energy harvesting systems, electrommechanical devices, and chemical and biological sensors, etc. For practical device applications of ZnO nanostructures, it is crucial to grow them selectively on wanted areas of substrate either in vertical or horizontal direction. The growth of vertically-aligned ZnO nanorods on substrates has been performed by various methods such as vapor-liquid-solid growth with metal catalysis, nanosphere-masking lithography, photolithography, and electron-beam lithography. However, as for lateral growth of ZnO nanorods, it is even difficult compared to the vertical growth, so limited papers were reported. The lateral growth methods previously reported are not able to completely eliminate the vertical growth components, complex structural networks, intersection of nanowires in the middle between electrodes, the sparse growth of nanowires with poor lateral alignment, and the use of expensive single-crystalline ZnO substrates. We developed a hybrid method for the lateral growth of multiple ZnO nanorods between electrodes in solution without the use of a metal catalyst. This method enables us to directly align a number of nanowires between electrodes with or without intersection in the middle and to completely eliminate the vertical growth components and complex structural networks. In this talk, a state-of-the-art related to the controlled selective growth of ZnO nanostructures and their applications for nanodevices will be discussed. Especially, the selectively pattern-controlled ZnO nanorods will be emphasized for the fabrication of high performance field-effect transistors (FETs) and FET-based biosensors for detecting glucose and cholesterol with high sensitivity and selectivity.