Field Effect Transistor Performance of Hydrothermal ZnO Nanowires

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The development of controlled nanowire growth routes for field effect transistors (FETs) is attractive for many electronic device applications including sensors.[1] ZnO is a prime candidate for FET sensing applications due to the material stability and the ease of fabricating ZnO nanowires with low cost hydrothermal methods.[1] Hydrothermal ZnO nanowires have gathered a lot of interest since the development of simple and robust synthesis routes by Vayssieres[2] in 2003 and have so far been used extensively for energy applications, such as photovoltaics[3,4] and mechanical energy harvesting.[5] More recently hydrothermal ZnO nanowires have been demonstrated as the active channel region in FETs.[6]

Here we will outline a synthesis route for ZnO nanowire transistors, where the nanowires are confined to controlled locations. Initial patterned seed layers of ZnO capped with Ti are fabricated by photolithography and lift-off. The ZnO layer is then etched for a short time in oxalic acid. The entire substrate is loaded into the nanowire growth solution, containing zinc nitrate and hexamethyltetramine and in some instances polyethylimine to control the ZnO nanowire aspect ratio.[7] Figure 1 shows a schematic of the fabrication process and a top down view SEM image of hydrothermal ZnO nanowires. The morphology of the nanowires can be altered depending on the chemical composition of the growth mixture and by the confinement of the available growth area using lithography. An example of transfer characteristics for an as grown ZnO NW FET is shown in figure 2. The post growth processing steps and the resulting FET behaviour and performance will be discussed along with the potential of the methods for nanowire device platforms.

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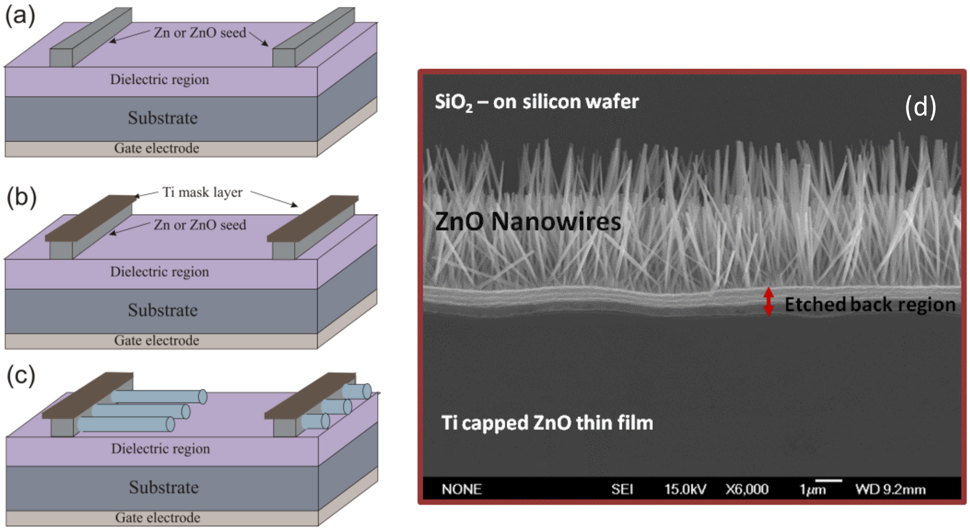

Figure 1: A schematic of the ZnO nanowire fabrication process (a) a ZnO seed layer is patterned by lithography (b) the ZnO is capped with Ti (c) the chip is placed in the nanowire growth solution and nanowires are selective grown from the exposed ZnO seed region (d) the patterned top down view of hydrothermal ZnO nanowires grown on a SiO_2/Si substrate

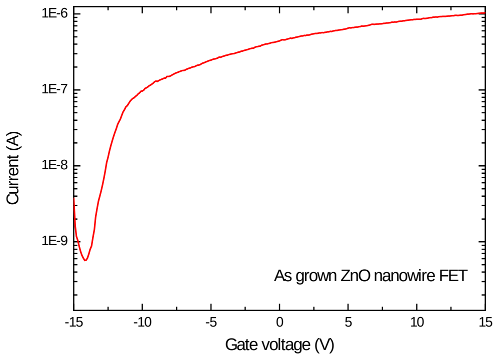

Figure 2: An example of a ZnO NW FET grow in a controlled location.