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Structural, optical and electrical characterization of zinc oxide monocrystalline layer and nanorods obtain by the atomic layer deposition method.

Zinc oxide (ZnO) is extensively studied as a prospective material for electronic, optoelectronic devices and transparent electrodes for solar cells. These ZnO layers deposited at low temperature (below 250°C) using organic zinc precursors exhibited polycrystalline and hexagonal structures of the wurtzite type. In my paper I described growth of monocrystalline ZnO films with (0001) orientation on either gallium nitride (GaN) or aluminum oxide (Al_2O_3) substrates. These ZnO layers were deposited at still relatively low temperature, which varied between 250°C and 300°C. This is important because some of new applications of this material, like three-dimensional memories, require high quality ZnO films grown at temperature that does not exceed 350°C. As zinc and oxygen precursors I used dimethylzinc (DMZn) or diethylzinc (DEZn) and deionized water, respectively. High resolution X-ray diffraction analysis confirmed that my ZnO layers were monocrystalline with lattice parameters a=3.2502 Å and c=5.2070 Å corresponding to those reported for bulk monocrystals. This makes the ALD method very prospective for deposition of ZnO films for various devices with very good electronic and optoelectronic properties.

In the second part of my work I obtained ZnO nanowires (NWs) with controlled physical properties. As a substrate I used gallium arsenide (GaAs) with a gold eutectic mixture prepared on the surface at high temperature (800°C). To obtain the eutectic solution I spread a gold thin film on GaAs and then I annealed the samples in a nitrogen gas flow. Au-Ga droplets were achieved in this way. The so-prepared substrates were used for growth of ZnO NWs using the ALD system. I used deionized water and zinc chloride as an oxygen and zinc precursors respectively. The eutectic mixture played a role of catalyst for the ZnO NWs growth. Au-Ga droplets flowed on the front of growth forcing the growth of ZnO NWs. SEM images showed ZnO nanorods in a form of crystallites of up to 1 µm in length and 100 nm in diameter. It was the first demonstration of the ZnO NWs growth by ALD using VLS (vapour-liquid-solid) approach. Structural, optical and electrical properties of the ZnO NWs were characterized using XRD, PL and electrical measurements, respectively.

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