ZnO based Heterostructures for Optoelectronics and Magnetoelectronics

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Due to its specific properties, ZnO has recently attracted considerable attention as a semiconducting material. The high exciton binding energy of 60 meV enhances excitonic effects e.g. in stimulated emission. Also, the incorporation of magnetic ions is believed to lead to ferromagnetic behavior. In addition, a self-organized growth mode can be initiated in order to fabricate ZnO nanopillars with a quite homogenous size distribution. Therefore, ZnO seems to be a very versatile material platform in the field of optoelectronics, magnetoelectronics, and nanoelectronics. Here, we report on the development of growth process technology based on both MOVPE and MBE in order to establish a basis for the exploitation of ZnO heterostructures and nanostructures. The strain situation of ZnO layers grown on GaN/Sapphire templates has been analysed in detail. It turns out that the coalescence of islands is the reason for the tensile strain in these structures. The fabrication and properties of ZnMgO-ZnO quantum well structures will be reported. In addition, MOVPE can be used to initiate a growth mode resulting in the self-organized growth of ZnO nanopillars with a typical width of only 50 nm and a height of up to 5 μm. These free-standing nanopillars show intense PL spectra, despite their small diameter, with FWHM below 0.5 meV. HRXRD analysis shows that these nanopillars – depending on the growth mode – can be almost completely cooriented. In an attempt to control the composition of these nanopillars, we incorporated both Mg as well as V into the ZnO nanorods. The ZnVO nanorods showed ferromagnetic behavior, with an easy axis in the direction of the nanopillar, vertical to the substrate. The potential and state of the art of magnetic ZnO for spinelectronics will be discussed.