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Metallorganische Gasphasenepitaxie und Charakterisierung homoepitaktischer ZnO-Schichten

Abstract

ZnO is a direct semiconductor with a bandgap of 3.37 eV and an exciton-binding-energy of approx. 60 meV. The bandgap can be tuned between 2.9 eV and 4 eV by alloying with Cadmium or magnesium, which offers the realization of e. g. quantum-well-structures. Therefore ZnO is a material with a tremendous potential for optoelectronic devices in the blue and near ultraviolet spectral regime. Despite worldwide numerous research activities over the last years, reproducible and long-time-stable p-type ZnO is still difficult to achieve.

In this work the ZnO-layers were grown by metalorganic vapour phase epitaxy. On the basis of investigations of undoped, heteroepitaxially grown layers I'll show the limits of heteroepitaxy. The introduction of a 3-step growth process leaded to improved physical properties (morphology, luminescence, crystal structure and electrical properties) of the topmost layer. Nevertheless in doping experiments no p-type ZnO could be grown. However, the formation of a highly conductive interlayer in the vicinity of the substrate/ZnO-interface could be verified. During the growth of heteroepitaxial ZnO the formation of this interlayer can not be avoided.

Since approx. three years are ZnO-Substrates with a high quality commercially available. Therfore the main part of this work deal with my works to the homoepitaxy of ZnO.

Before growth the substrates must be annealed. During the annealing the substrates are located in an environment with ZnO-powder and an oxygen atmosphere. The optimal annealing conditions were found and the effect of the thermal treatment upon the physical properties of the substrates were investigated. After the annealing the substrates are epi-ready.

The experiences from heteroepitaxy could not brought forward to homoepitaxy. In the beginning the quality of the homoepitaxial layers were very bad but could be improved by systematically changing of the growth conditions. For the first time worldwide we obtained homoepitaxial layers which were grown in a two-dimensional growth mode by using pure O_2 as oxygen-precursor (instead of N_2O).

On the base of such layers p-doping experiments were performed with arsenic as dopand. Instead of p-type ZnO the formation of an electrical isolating Zn/As/O-alloy was observed. This alloy could be identified as $Zn_3(AsO_3)_2$ – Reinerite.