Abstract

In this thesis I present an *in situ* X-ray diffractometer for X-ray diffraction analysis of epitaxial layers during metal-organic chemical vapor deposition. The conception of the *in situ* X-ray diffractometer, the model of data interpretation and the description of the experimental setup are given in detail. The diffractometer has been constructed and tested under laboratory conditions with wurtzite type AlGaN- and InGaN-based materials. The results of tests show that the diffractometer allows to perform X-ray diffraction measurements under conditions present in a metal-organic chemical vapor deposition reactor and to obtain accurate information about the composition and relative thickness (growth rate) of epitaxial layers. The results of measurements have been compared with the results obtained by conventional high resolution X-ray diffractometer and perfect agreement has been reached.

The diffractometer has been developed without a goniometer stage. It is not sensitive to precise alignment of the samples before measurements and it has very short data collection time (up to factor 100 less than by standard diffractometers). These additional features of the X-ray diffractometer makes it well suited for extremely fast post-growth diagnostics of multilayer semiconductor structures. This potential of the diffractometer has been tested with different materials systems which are important in the semiconductor industry today, namely wurtzite AlGaN single heterostructures, wurtzite InGaN-based multiple quantum wells and SiGe heterostructures. The measurements of the line scans as well as of reciprocal space maps are presented and analyzed in terms of composition, periodicity of the multilayers and status of strain. All results are in good agreement with the results obtained by conventional high resolution X-ray diffraction.