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SUMMARY of DOCTORAL DISSERTATION

"Development of *in situ* characterisation methods for MOVPE deposition of nitride films (AIIIN)"

Heterostructures based on nitrides of the third group of the periodic table (AIIIN) are used in modern semiconductor devices such as microwaves and high-power transistors, in optoelectronic components (light-emitting diodes and UV/DUV laser diodes) and in sensors, e.g., surface acoustic wave gas sensors. Heterostructures, depending on their properties and purpose, are fabricated on substrates made of silicon carbide (SiC), sapphire (Al_2O_3), and silicon (Si). The main limitation of the heteroepitaxial process is the mismatch between the lattice constants of the epitaxial layer and the semiconductor substrate and the mismatch between their thermal expansion coefficients. The difference in the dimensions of the epitaxial layer's elementary cells and the substrate is the main reason for the formation of a large number of defects in the crystallizing structure of the layers. Therefore, a thick, homogeneous buffer layer with defined properties (e.g. doping level) is required for the fabrication of modern semiconductor devices based on AIIIN compounds. *In situ* characterisation of process parameters and material deposited allows epitaxial layers of the expected thickness, composition, and low stresses within the structure to be produced. Analysis of the temperature, temperature inhomogeneity, growth rate, and thickness of the epitaxial layer, as it grows, allows real-time action on the process and control of the reproducibility of the layers' properties produced in subsequent processes. Existing methods for *in situ* characterisation of epitaxial layers typically use analysis with the use of discrete wavelengths. This is mainly due to the design of the measurement equipment and easier interpretation of the data obtained, but when only discrete wavelengths are used, some of the information contained in the entire spectrum is lost. Devices analysing the *in situ* spectrum of radiation allow the determination of both the process parameters and the crystallised material, and the determination of previously unanalysed parameters such as the temperature dependence of the deposited layer absorption edge. In addition, spectral measurements enable statistical analysis at selected wavelengths and precise determination of process parameters.

The aim of the dissertation was to develop a measurement station for spectral measurements inside a steel MOVPE (Metalorganic Vapour Phase Epitaxy) epitaxy reactor, AIXTRON type CCS 3x2", and to develop a measurement methodology to analyse parameters such as layer thickness, growth rate, and, indirectly, temperature of the epitaxial layer with the use of the temperature dependence of energy bandgap changes.

The tests carried out confirmed high precision and repeatability of the data obtained and indicated limitations of the measurement system used and the measurement methodology

developed. The designed measuring device enables comprehensive *in situ* analysis of the epitaxy process of nitrides of the third group of the periodic table and does not require the use of expensive light sources or advanced optical spectrometers.

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PhD student signature