Nepolinio ir pusiau-polinio GaN auginimas ant Si su Er_2O_3 tarpsluoksniu

Non-polar and semipolar GaN growth on Si with Er_2O_3 interlayer

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Conventional polar group-III nitrides MQW structures suffer from internal electric fields, which lead to band bending and a decreased efficiency and spectral instability of optoelectronic devices [1]. The internal electric fields can be reduced or totally avoided with semi-polar or non-polar GaN growth [2]. However, growth of such orientations is still costly. Integration of GaN to Si technology is a direct way for reducing the price of a new generation of devices applied in optoelectronics, photovoltaics and high power electronics. A large difference in thermal expansion, a mismatch in lattice and chemical reactivity must be solved in order to grow crack free, high quality epitaxial GaN films on Si. One possibility to integrate GaN on Si is the heteroepitaxial growth using rare earth oxides as a buffer [3]. This study is aimed to develop growth technology of non-polar and semipolar GaN on Si substrates using Er_2O_3 as the buffer layer.

Thick Si (100) substrates were overgrown with a 300 nm-thick Er_2O_3 (110) buffer layer by MBE (Fig. 1). Afterwards, a close-coupled showerhead metalorganic chemical vapor deposition reactor (MOCVD) was used to grow GaN on top of these templates in several growth campaigns. Growth conditions such as temperature, V/III-ratio, carrier gases and others were varied. The structural and optical properties of the grown epitaxial structures were investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM) and photoluminescence (PL) techniques.

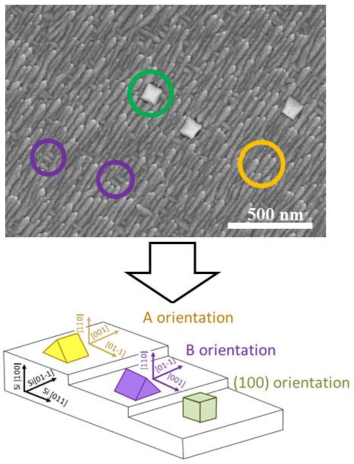

Fig. 1 Er_2O_3 surface morphology prior GaN growth (SEM) and corresponding oxide domains scheme.

The XRD investigation showed the polycrystalline nature of GaN layers with dominant non-polar (11-20) and semipolar (10-13) orientations (Fig. 2). More detailed texture analyses revealed that both dominant GaN orientations are formed by growth of {0001} GaN planes parallel to the {111} facets of Si, thus causing the twinning of GaN layers. The c-axis in semipolar GaN is inclined by 33.17° from the substrate surface, and is tilted towards opposite in-plane directions for different twins. By analyzing SEM images taken under different sample tilt angles the facets of grown truncated pyramid GaN were identified, and 3D pyramids were reconstructed. The data was used to obtain kinetic Wulff diagrams, which were used to explain the preferential growth of (10-13) GaN. The PL spectra of semi-polar and nonpolar GaN showed a near band edge emission including luminescence from the stacking faults. A red shift was observed in spectra due to the expected thermal induced tensile strain in GaN.

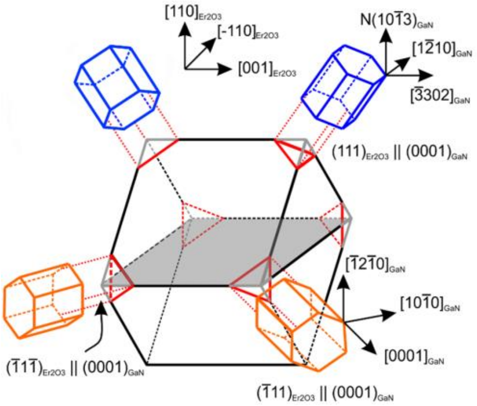

Fig. 2 GaN growth on cubic Er_2O_3 lattice scheme.

Reikšminiai žodžiai: GaN, nonpolar, semipolar, MOCVD, Er_2O_3

Literatūra

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