BUFFER ENGINEERING OF ALGAN CHANNEL TRANSISTORS ON SILICON GROWN BY MOLECULAR BEAM EPITAXY FOR HIGH VOLTAGE APPLICATIONS

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Development of Ultra-Wide Band-Gap semiconductor devices driven by superior fundamental material is of great interest for power and radiofrequency applications. With a tunable band-gap up to 6 eV and a high critical breakdown field (BF), AlGaN is a promising material alloy. We aim to develop AlGaN channel HEMTs on silicon to demonstrate breakdown voltage (BV) above 1kV. Growth of thick AlGaN structures using strain engineering is needed to achieve such values. In this study, we propose to investigate $Al_{0.3}Ga_{0.7}N$ structure with a specific focus on the influence of the buffer layer stack.

Growth is carried out using NH_3-MBE. Buffer layers using an AlGaN interlayer (IL) are developed to achieve crack-free thick AlGaN-on-Si. Two different ILs are compared regarding structural (X-ray diffraction) and electrical (Hall and vertical I-V measurements) properties.

State of the art mobility values (340cm²/V.s) are achieved for $Al_{0.3}Ga_{0.7}N$ channel HEMTs on Si. Despite good material qualities, BV does not scale with the AlGaN thickness suggesting that other parameters affect BV. This study focuses on the presence and role of buried-cracks located within the AlGaN IL.

This work demonstrates the ability of NH_3-MBE to grow high-quality and high-uniformity AlGaN channel HEMTs showing preliminary results on 200 mm Si substrates. Promising BF values above 3 MV/cm are achieved but there is still a lot of room for improvements to achieve the expected BV. Increasing Al compositions combined with AlN barriers and optimizing the buffer layer stack should strongly enhance the device's figures of merit.