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# Study on Pressure-dependent Growth Rate of Catalyst-free and Mask-free Heteroepitaxial GaN Nano- and Micro-rods on Si (111) Substrates with the Various V/III Molar Ratios Grown by MOVPE

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Heteroepitaxial GaN nano- and micro-rods (NMRs) are one of the most promising structures for high performance optoelectronic devices such as light emitting diodes, lasers, solar cells integrated with Si-based electric circuits due to their low dislocation density and high surface to volume ratio. However, heteroepitaxial GaN NMRs growth using a metal-organic vapor phase epitaxy (MOVPE) machine is not easy due to their long surface diffusion length at high growth temperature of MOVPE above 1,000°C. Recently some research groups reported the fabrication of the heteroepitaxial GaN NMRs by using MOVPE with vapor-liquid-solid (VLS) technique assisted by metal catalyst. However, in the case of the VLS technique, metal catalysts may act as impurities, and the GaN NMRs produced in this mathod have poor directionallity. We have successfully grown the vertically well aligned GaN NMRs on Si (111) substrate by means of self-catalystic growth methods with pulsed-flow injection of precursors. To grow the GaN NMRs with high aspect ratio, we veried the growth conditions such as the growth temperature, reactor pressure, and V/III molar ratio. We confirmed that the surface morphology of GaN was strongly influenced by the surface diffusion of Ga and N adatoms related to the surrounding environment during growth, and we carried out theoretical studies about the relation between the reactor pressure and the growth rate of GaN NMRs. From these results, we successfully explained the growth mechanism of catalyst-free and mask-free heteroepitaxial GaN NMRs on Si (111) substrates. Detailed experimental results will be discussed.

**Keywords:** GaN, nanorod, MOCVD, MOVPE