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Raman spectroscopy of GaN nucleation and free-standing layers grown by hydride vapor phase epitaxy on oxidized silicon

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GaN nucleation layers (NL-GaN) and GaN free-standing (FS-GaN) layers are studied using Raman spectroscopy and atomic force microscopy. The layers are deposited onto oxidized silicon substrates by hydride vapor phase epitaxy at 520 °C (NL layers) and 970 °C (FS layers). The effect of high-temperature annealing (1010 °C) on the properties of FS-GaN layers is investigated. The average height of the islands in the NL-GaN layers is found to increase from 15 to 400 nm when the growth time is increased from 10 to 200 min. The average growth rate of NLs is found to be very low, namely, $\approx 1\times10^{-2}$ nm/s. E_2 (566 cm^{-1}) and A_1 (longitudinal optical) (730 cm^{-1}) peaks are observed on NL-GaN layers when the average size of the islands increases to 400 nm, scattering by E_2 (567.3 cm^{-1}) and E_1 [transverse optical (TO)] (558.3 cm^{-1}) modes is detected on FS-GaN layers. High-temperature annealing of the FS-GaN layers results in an increase of the intensity of E_2 and E_1(TO) peaks detected from the front side whereas no effect is observed for detection from the side exposed by removal of the substrate.

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