Study on HCl-based Wet Chemical Cleaning of Epitaxial GaN(0001) Surfaces

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Introduction> GaN surface cleaning is a crucial issue from viewpoints of controllability and reproducibility in device fabrication processes involving device performance and its reliability [1]. It was well known that cleaning with HCl solution is effective to remove the metal contaminants at semiconductor surface. In this work, we have studied the change in the chemical states of GaN(0001) surface by wet-chemical treatment using HCl solution.

Experimental Procedure> A ~2 µm-thick n-type GaN(0001) with a Si concentration of 5×10^{16} cm^{-3} was epitaxially grown on a free-standing GaN substrate by MOCVD. After the ultrasonic cleaning of GaN surface using acetone and IPA solutions, the surface was immersed in diluted HCl solution (3~36%) at RT or 80 ºC for 20 min.

Results and Discussion> Figure 1 shows the AFM topographic images taken for GaN surfaces before and after ~15% HCl treatment. For the initial surface before the treatment, a clear step-terrace structure was observed. After HCl treatment at RT, some protrusions with an areal density of ~1.1×10^{10} cm^{-2} were detected on GaN surface. On the other hand, the protrusion density was lower after the treatment at 80 ºC. Observed protrusion at GaN surfaces after HCl treatment at RT and 80 ºC were plotted as a function of HCl concentration as shown in Fig. 2. With HCl concentration increasing, the protrusion density is gradually increased. We found that the formation of protrusions by HCl treatment can be effectively suppressed by an increase in the treatment temperature.

Summary> HCl treatment of GaN(0001) induces surface protrusions, and this protrusion formation can be suppressed by an increase in the temperature.

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Reference> [1] M. Diale et al., Appl. Surf. Sci., 246, 279 (2005).

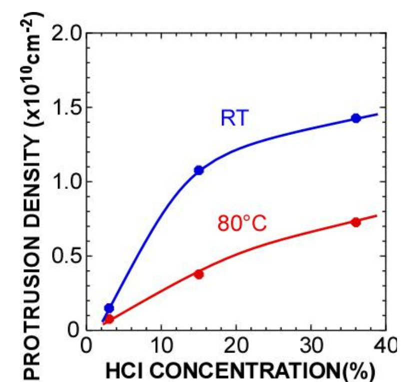

Fig. 2 Protrusion density on GaN surface formed by HCl treatment.

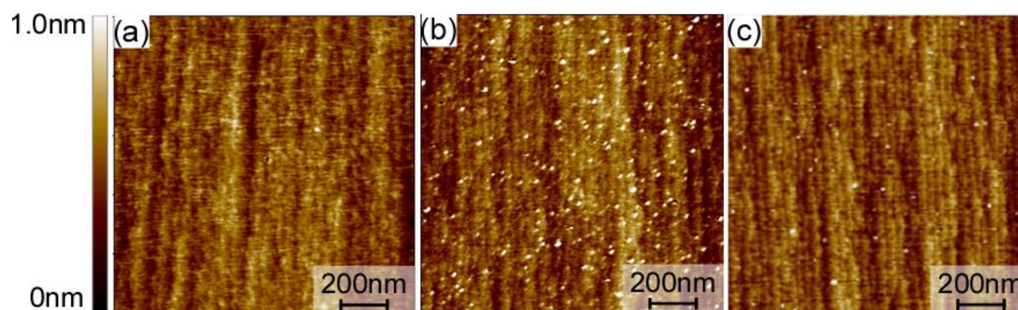

Fig. 1. AFM images of GaN (a) before and after 15% HCl for 20min at (b) RT and (c) 80ºC.

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