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Parametric Study of Dry Etching of Doped GaN in Chlorine-Based Inductively Coupled Plasmas

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Cl_2-ICP를 이용한 Doped GaN 식각의 공정변수적 연구

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A strong development effort of dry etching has been directed due to the absence of convenient wet etch processes for group III-niotrides. Dry etching techniques using high density plasmas such as inductively coupled plasma (ICP) and electron cyclotron resonance (ECR) plasma have been successful in patterning of these materials. The most common use of dry etching so far has been the creation of mesas in light-emitting diodes (LEDs) to expose n-side of junction, or to form a ridge waveguide in laser diodes. In these applications the main focus has been on obtaining the relatively large etch depths (2 - 4 ㎛) typical of ridge or facet heights, where the final surface morphology on the field is less important.

In this work, a parametric study of inductively coupled plasma (ICP) etching of GaN, n-GaN and p-GaN with Cl_2/Ar discharges has been carried out. The effects of etch gas concentration, reactor pressure, rf chuck power and ICP source power on etch rates have been investigated. The effect of frequency of chuck power source was also examined. The epitaxial GaN films were on c-plane α-Al_2O_3 by metal organic chemical vapor deposition (MOCVD), and were etched in a homemade ICP reactor.

The etch rates were greatly affected by plasma composition, pressure, rf chuck power and ICP source power, implicating that optimization of the etching process variables is important to obtain a desired pattern. The etch rates increased substantially with increasing the rf chuck power, indicating that breakage of Ga-N bond is crucial for practical etching of group III-nitrides. The doped GaN showed somewhat higher etch rates than those of undoped GaN, and p-GaN showed greater etch rate than n-GaN. Higher frequency of 13.56 MHz of the rf chuck produced greater etch rates and smooth morphology than with 400 KHz.

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