Selective Dry Etching of InN/AlN/GaN System in Cl_2-, ICl- and IBr-Based Inductively Coupled Plasmas

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Cl_2, ICl 및 IBr 유도병합 플라즈마를 이용한 InN/AlN/GaN 계의 선택적 식각

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High density plasma etching techniques have been successful in patterning of III-nitrides for photonic device applications such as laser diodes and light-emitting diodes (LEDs). Currently, all of the LEDs and a majority of the lasers are ridge wave guide structures in which the mesas are formed by dry etching. Correspondingly, most of the previous etching studies have been focused 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. Attention is now turning to the development of GaN-based high power/high temperature electronics for power switching and transmission applications. In these devices, the etch depth is much shallower, but smooth morphologies and high selectivities for InN over the other nitrides are required because layers based on InN will probably be used to obtain low ohmic contact resistance.

In this work, a parametric study of ICP etching of GaN, AlN and InN with Cl_2-, ICl- and IBr-based plasma chemistries has been carried out. The effects of etch gas concentration, rf chuck power and ICP source power on etch rates and selectivity have been investigated. The ICP discharges are well suited for achieving controllable etch rates (500-1500 Å/min) and high selectivities (up to 80) for InN over AlN and GaN.

In Cl_2-based discharges, the etch rates were greatly affected by plasma composition, rf chuck power and ICP source power. The highest etch rates for InN were obtained with Cl_2/Xe, while the highest rates for AlN and GaN were obtained with Cl2/He. In ICl- and IBr-based chemistries, the etch rates of InN and AlN were relatively independent of plasma composition, while GaN showed increased etch rates with interhalogen concentration. Maximum selectivities of ~ 80 for InN to GaN and InN to AlN were obtained with the Cl_2-based discharges; ~ 14 for InN over GaN and ~ 30 for InN over AlN with ICl and IBr plasmas.

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