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Abstract
For the etching process, inductive coupling plasma (ICP) was used with a Cl2/Ar mixed gas as, an etching source。Results showed (1) an etch rate of 7000 Å/min was achievable at Cl2＝20sccm, and it was found that etch rate decreased when Cl2＞20sccm possible due to the formation of nonvolatile GaClx by product on the etched GaN surface。(2) Etch rate increased with the process pressure, and the maxmum etch rate was obtained at presure＝10 mtorr。(3) Etch rate increased with platen power and ICP power。 and the maxmum etch rate of 7200 Å/min was found at the conditions of presure＝10 mtorr、platen power＝450W and ICP power＝800W。(4) Based on the characteristics of the etch surface, such as optical properties, surface morphology and states, the optimum etching process parameters were presure＝2 mtorr, platen power＝300W, ICP power＝800W and Cl2/Ar＝20/10。

For GaN-based material annealing process, the effect of annealing temperature & time in N2 ambient to the luminescent mechanics of photoluminescence (PL) was monitored. It was found that the best mobility and carrier concentration value of 252 cm2/V-s and 2.48×1018cm-3, respectively,were achieved at 750℃ for 20 min thermal annealing。

From TEM obserration, it could be clearly observed that numerous threading dislocation defects (TD) occurred at GaN/Sapphire interfaces because of giant lattice mismatch between these two materials。 From AFM images, it could be seen that there were many small inversion-domain-boundary (IDB) defects on sample surface. These defects seriously affect the optoelectronic characteristics and surface roughness of the GaN layers.
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