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Supplementary Information

Regulation of surface kinetics: Rapid growth of n-AlGaN with high conductivity for deep-ultraviolet light emitters

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I. Calculation-related parameters

Since the supersaturation of Al is several orders of magnitude higher than that of Ga,[1] in other words, the surface diffusion capability of Al is much weaker than Ga, the Al nucleation on the terrace is much easier to occur than Ga during AlGaN growth, making it the main limit of the growth rate. Therefore, the correlation between the growth temperature and critical growth rate of Al is firstly calculated, and then the critical growth rate of AlGaN is obtained according to[2]

$$x = \frac{R_{Al}}{R_{Al} + R_{Ga}} \tag{1}$$

$$R_{AlGaN} = R_{Al} + R_{Ga} \tag{2}$$

where x, R_{Al} and R_{Ga} are the Al composition (0.55 here), growth rate of Al and Ga, respectively.

Table S1. Related parameters in the calculation for $Al_{0.55}Ga_{0.45}N$.

Parameter	Value
Lattice constant *a*	0.3112 nm for AlN 0.3189 nm for GaN
Lattice constant *c*	0.4982 nm for AlN 0.5186 nm for GaN
λ_s	$\lambda_s = \lambda_e exp\left(\frac{E_{ad} - E_d}{2kT}\right)$ $E_{ad} - E_d = 1.312$ eV [3]
Equilibrium constant for AlN	$Al(g)+NH_3(g)\leftrightarrow AlN(alloy)+3/2H_2(g)$ $K_{AlN} = \frac{a_{AlN}P_{H_2}^{\frac{3}{2}}}{P_{Al}P_{NH_3}} = exp\left(-\frac{\Delta G}{kT}\right)$ ΔG=580480+112.6T J/mol [4]
Decomposition efficiency of NH_3	0.2 [1]
$\frac{n_{s0}}{\tau_s}$	$\frac{n_{s0}}{\tau_s} = \frac{P_{Al}}{\sqrt{2\pi m_{Al}kT}}$ $P_{Al}^4 + \left(2xB + \frac{8a_{AlN}^2}{xK_{AlN}^2}\right)P_{Al}^3 + \left(x^2B^2 - \frac{12Aa_{AlN}^2}{K_{AlN}^2}\right)P_{Al}^2 + \frac{6a_{AlN}^2xA^2}{K_{AlN}^2}P_{Al} - \frac{a_{AlN}^2x^2}{K_{AlN}^2}A^3 = 0$ [1] $A = \frac{2}{x}P_{Al}^0 + P_{H_2}^0$ and $B = P_{NH_3}^0 - \frac{P_{Al}^0}{x}$
R_{nuc}^*	10^{12}–10^{14} cm^{-2} s^{-1} [5]
V	2.17×10^{-23} cm^3
σ	14.9 eV/nm^2 for AlN (0001) [3] about 16 eV/nm^2 for GaN(0001) [6]

References

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II. Growth of the DUV-LED structure on 0.5° miscut sapphire

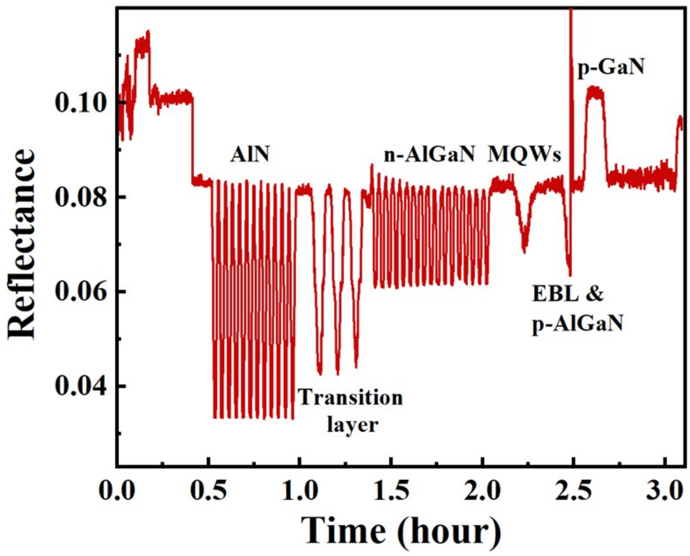

Fig. S1. In-situ optical reflectance (405 nm) curves for the DUV-LED structure on 0.5° miscut sapphire