Supplementary information

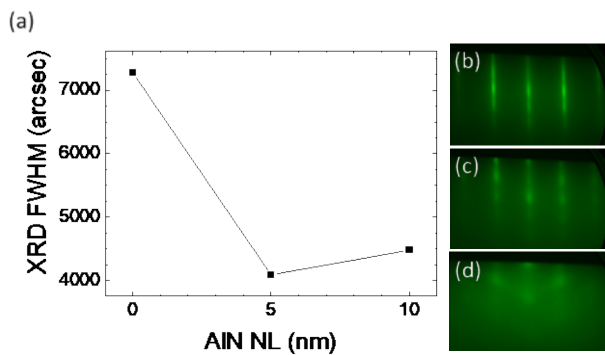

Figure 1. (a) XRD 0002 reflection RC FWHM for 150-nm $Sc_{0.33}Al_{0.67}N$ samples having various AlN nucleation layer (NL) thicknesses. RHEED patterns after (b) 5 nm of AlN growth, (c) 30 nm of $Sc_{0.32}Al_{0.68}N$ growth for the sample with a 5-nm AlN NL, and (d) 30 nm of $Sc_{0.32}Al_{0.68}N$ growth for the sample with no AlN NL.

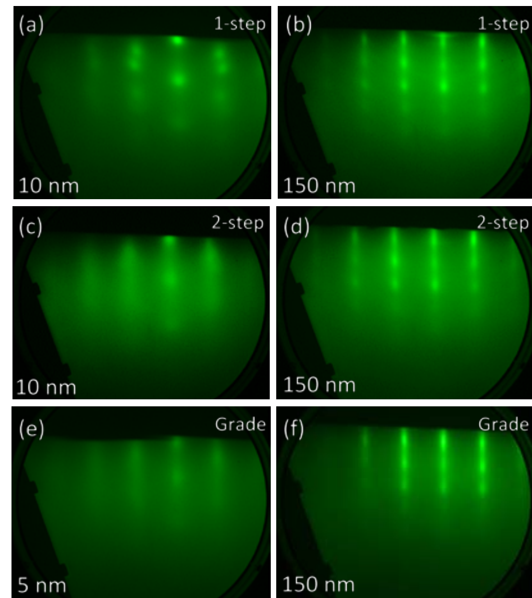

Figure 2. RHEED images of the (a, b) 1-step $Sc_{0.40}Al_{0.60}N$ sample, (c, d) 2-step $Sc_{0.32}Al_{0.68}N/Sc_{0.40}Al_{0.60}N$ sample, and (e, f) graded $Sc_{0.32\rightarrow0.40}Al_{0.68\rightarrow0.60}N/Sc_{0.40}Al_{0.60}N$ sample taken (a, c, e) just after nucleation and (b, d, f) after growth of the 150-nm total-thickness film.

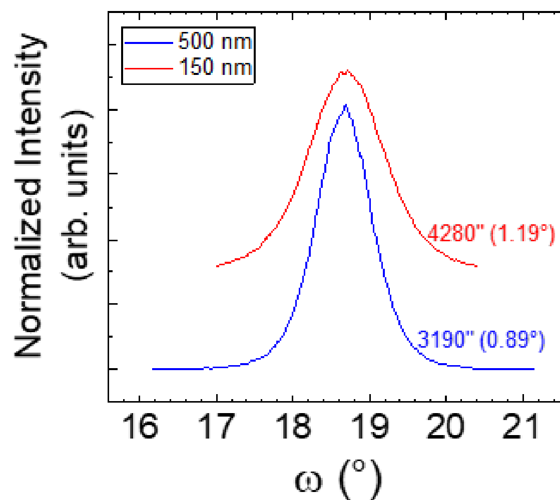

Fig. 3. (a) XRD 0002 reflection RC FWHM for 150-nm and 500-nm total-thickness samples employing a 100 nm $Sc_{0.32\rightarrow0.40}Al_{0.68\rightarrow0.60}N$ grade with the balance of the sample thickness being $Sc_{0.40}Al_{0.60}N$.

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