

Growth Conditions	Analysis <sup>a</sup>	Optimal Occurrence <sup>b</sup>
Temperature (°C)	500-700	670
Pressure (torr)	500	550
DEZn/ GeH <sub>4</sub>	11.0	9.0
(DEZn + GeH <sub>4</sub> )/TMGa	3.5	1.5
III/(II+IV+V)	1310.0	995.6
NH <sub>3</sub> F.R (μmol/min)	180	180
Rotation (rpm)	600	600

Figure 1. Composition versus TMGa flow rate for films grown on (0001) sapphire at 650 °C and 500 torr.

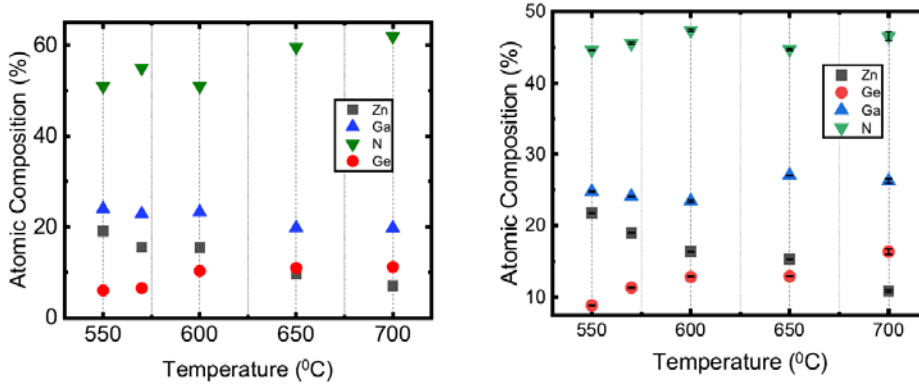


Figure 2. Composition versus growth temperature, for 30 μmol TMGa flow rate and 500 torr chamber pressure, and other growth conditions as shown in the table, (left) for films grown on (0001) sapphire substrates, (right) and, grown simultaneously on (1-102) sapphire substrates.

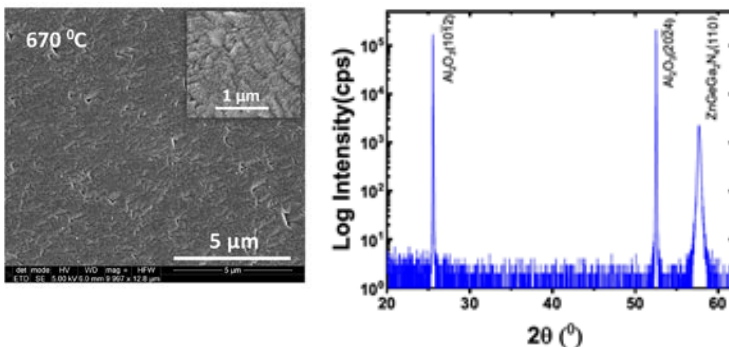


Figure 3. (left) SEM image of the “best” film grown to date, on r-plane sapphire at 670 °C and 550 torr. (right) 2θ-ω XRD scan of the film, showing the (110) peak of the alloy.

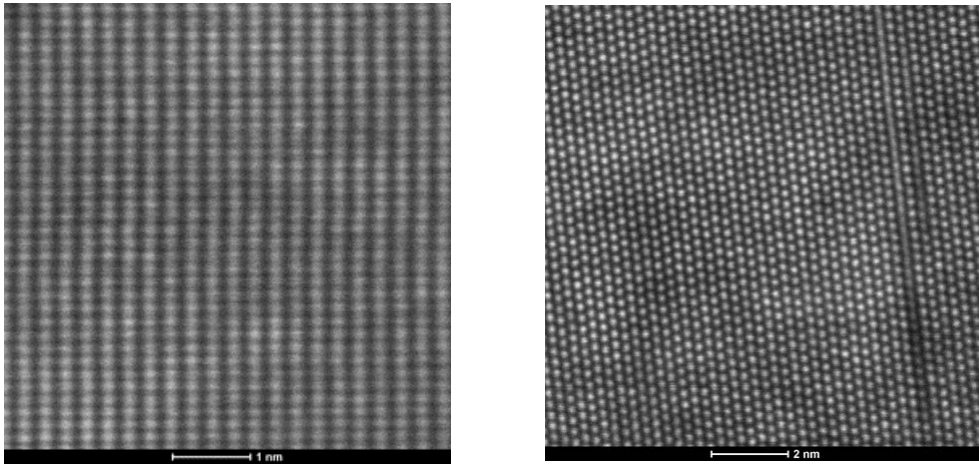


Figure 4. Atomic-resolution HAADF-STEM images of two different orientations near the interface of the “best” film grown to date, on r-plane sapphire at 670 °C and 550 torr, and conditions in column b of the table.

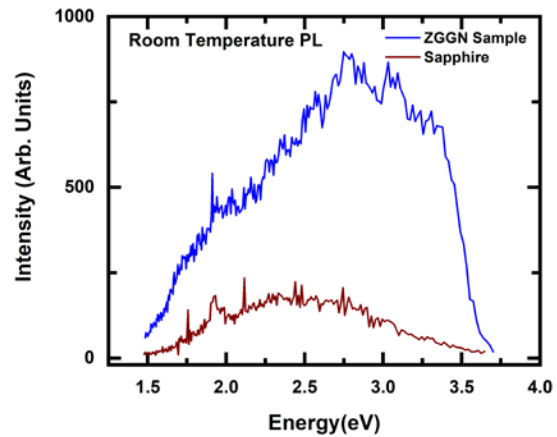
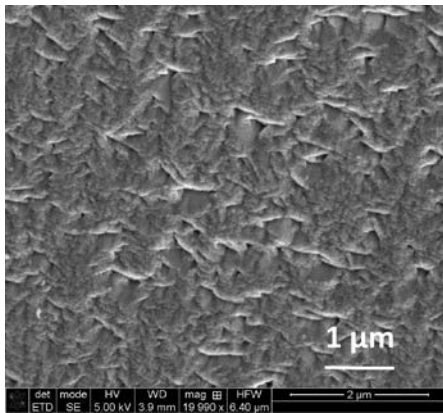
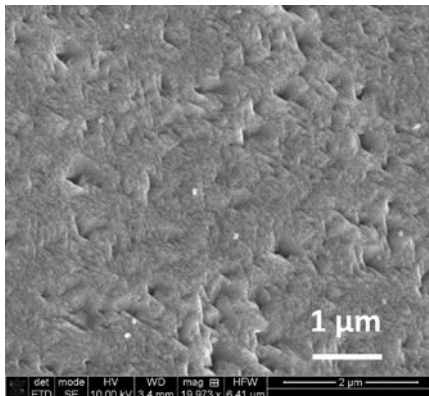


Figure 5. (left) SEM image of a  $\text{ZnGeGa}_2\text{N}_4$  film grown on r-sapphire with a low temperature  $\text{ZnGeN}_2$  buffer layer and (right) the PL spectrum at room temperature. Note the onset of PL indicating a band edge near 3.5-3.6 eV, and broad defect PL. The PL of a bare sapphire substrate at room temperature under the same excitation conditions (excitation wavelength 325 nm) is included for comparison.



Atomic Percent	
Zn	8.9
Ge	6.9
Ga	38.9
N	45.3

Figure 6. SEM image of a film with composition close to 25-75%  $\text{ZnGeN}_2$ -GaN. Atomic percentages measured by EDX are shown in the table.