以MOCVD成長InAlN/AlN/GaN異質結構之HEMT研究

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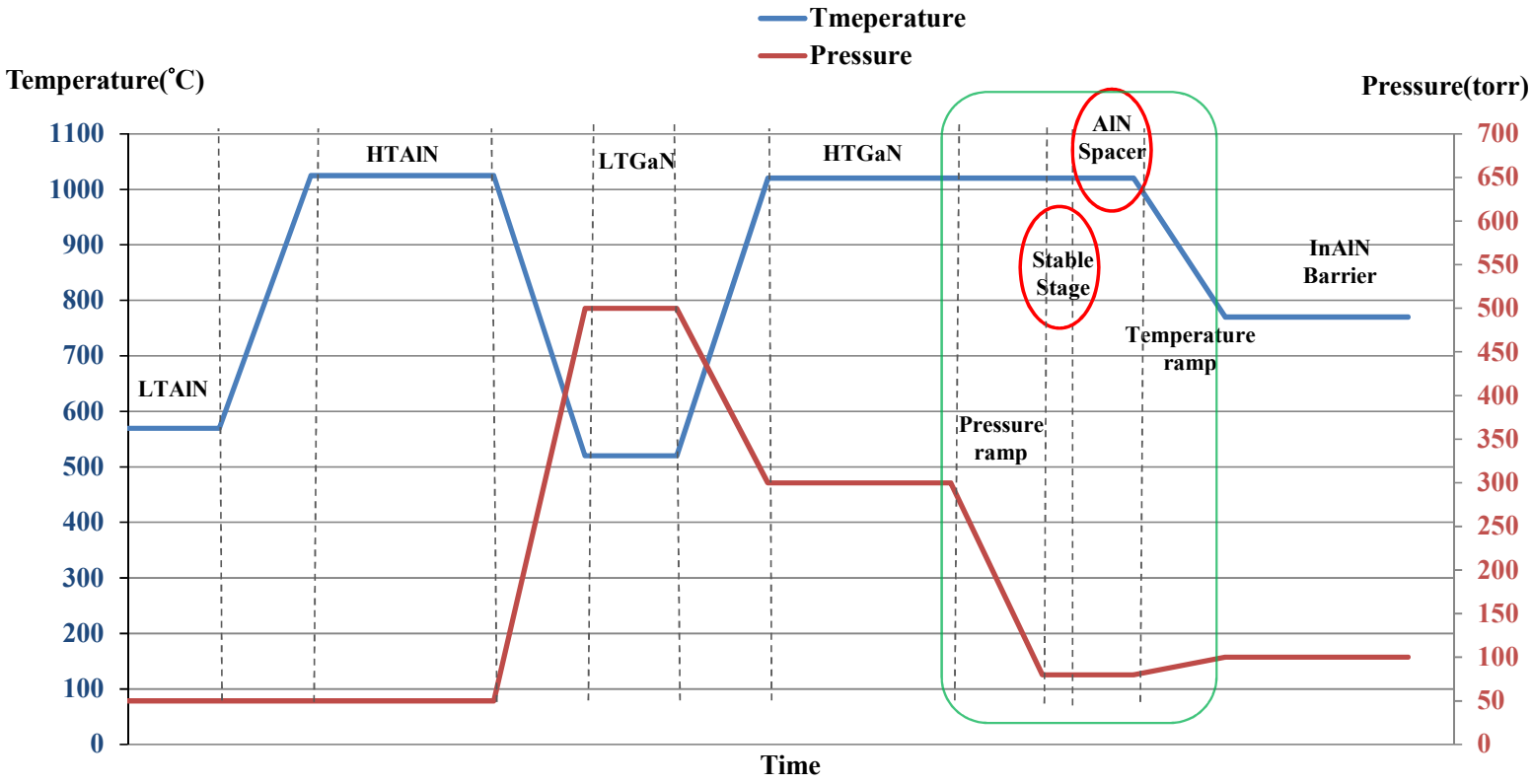
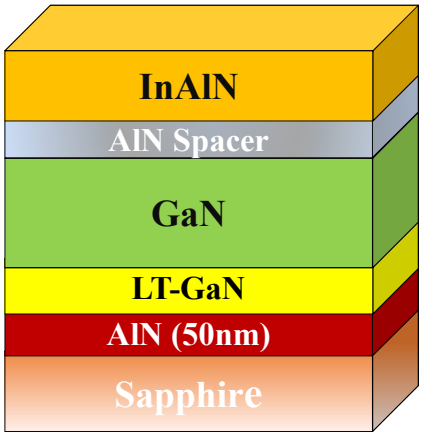
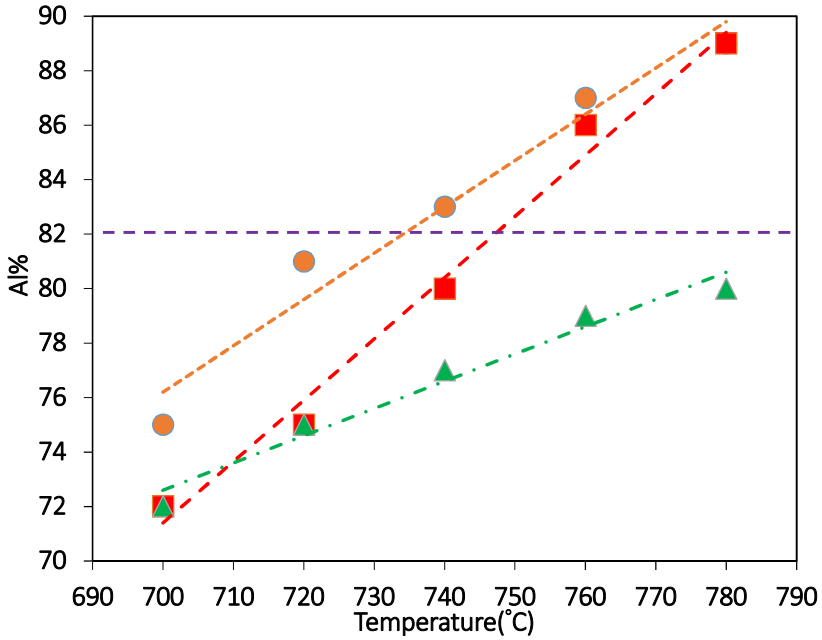
InAlN HEMT Structure and Growth Step

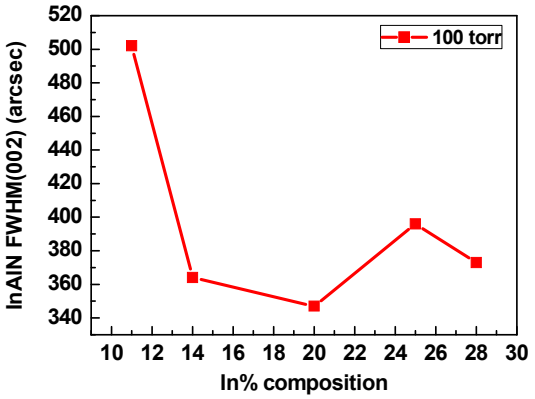
1. 準備2-inch(50.8mm)、C-place方向(<0001>)的sapphire基板，並先以攝氏1000度進行退火10分鐘以淨化表面
2. 在攝氏570度與NH_3進行氮化反應，此時sapphire表面(Al_2O_3)會慢慢轉變成AlN薄膜
3. 在攝氏520度成長LT-GaN複合物緩衝層，之後用Veeco D-180 vertical rotating disc reactor (RDR) MOCVD在攝氏1000度下成長GaN，且其V/III ratio為2063
4. 在攝氏1010度成長AlN spacer，並以氮氣作為載氣成長InAlN與$In_{0.18}Al_{0.82}N$薄膜

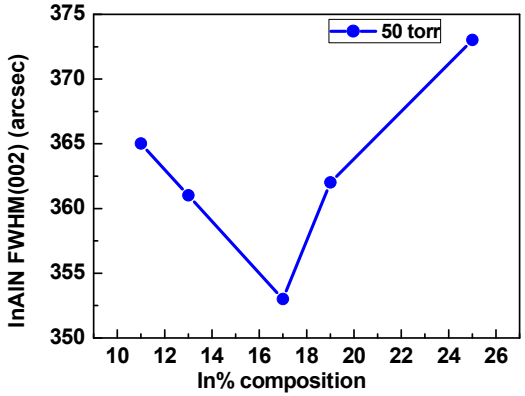


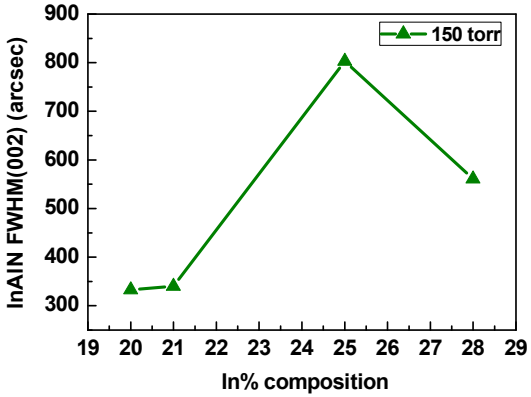


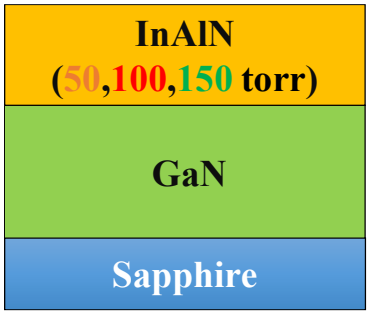
Effect of Growth Pressure and Temperature on InAlN







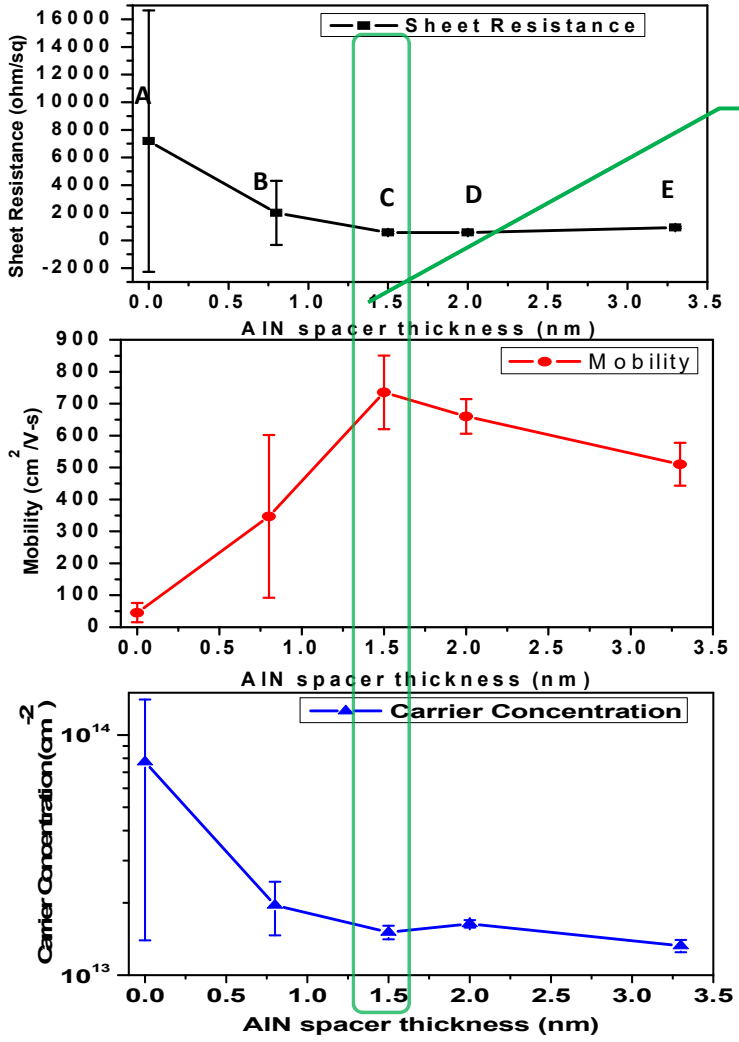




- At growth pressure of 100 torr, the Al atoms appear higher incorporation efficiency.
- Lower pressure causes to Al-rich InAlN
- Higher pressure causes to In-rich InAlN

- Growth InAlN at different pressure (50,100, 150), when the Indium composition of InAlN about **18%** , InAlN has better crystal quality.

Hall Measurement Results of InAlN HEMT with Different AlN Spacer Thickness



Rs: 537 (Ω/sq)
Mobility:851 (cm^2/V-S)
Ns: 1.365E13 (cm^{-2})

1
2
3
4
5
6

- From the Hall measurement, InAlN HEMT have the highest electrical property when 1.5nm AlN spacer thickness.
- The thickness of AlN too thin or too thick is not good for electrical property.

Sample	Spacer thickness(nm)	Rs (Ω/sq)	Mobility (cm^2/V-S)	Ns (cm^{-2})
C	1.5	537	851	$1.365e^{13}$
D	2	520	758	$1.584e^{13}$
E	3.3	815	637	$1.2e^{13}$

結論

- 1. Al的incorporation efficiency會隨成長壓力而變：低成長壓力使InAlN 中Al含量較高；反之高成長壓力會使InAlN 中In含量較高。而InAlN中之In比率約18%時，其擁有較好的crystal quality
- 2. 在AlN spacer的厚度為1.5 nm時，InAlN HEMT有最佳的電性：片電阻537 Ω/□ 、遷移率 851 cm2/V·s、載子濃度 1.365×1013 cm−2