Supplement Materials

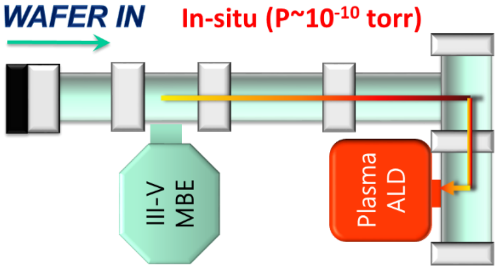

Fig. 1. Schematic showing part of our UHV multi-chamber growth/analysis system.

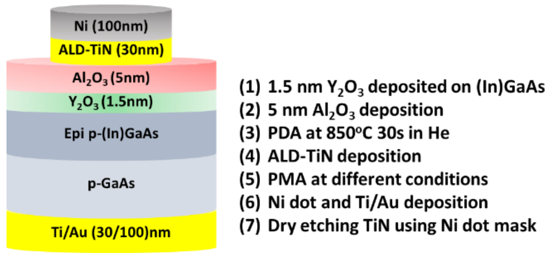

Fig. 2. ALD-TiN/Al_2O_3/Y_2O_3 MOSCAP structure on p-(In)GaAs (001) and MOSCAP fabrication process flow

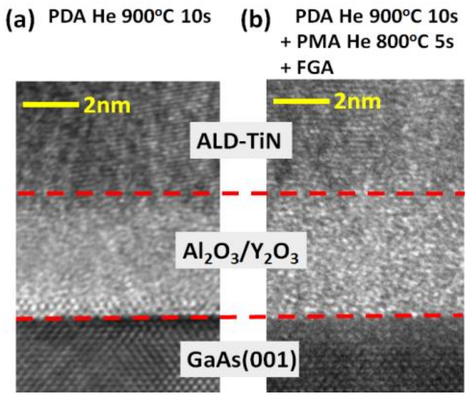

Fig. 3. cross-section TEM images of Al_2O_3(5nm)/ Y_2O_3(1.5nm)/(In)GaAs(001) (a) PDA of 900ºC 10s in He followed by 30nm ALD-TiN deposition and (b) further PMA of 800ºC 5s in He and forming gas annealing

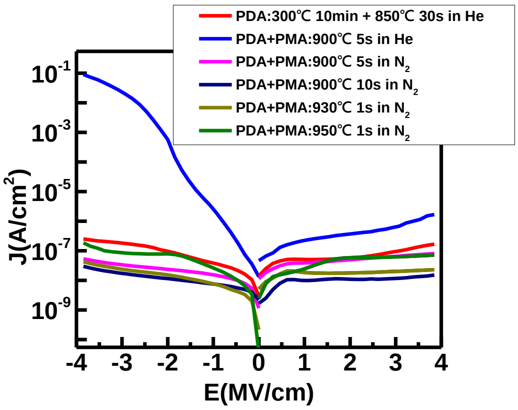

Figure 4. J-E characteristics of Al_2O_3(5nm)/ Y_2O_3(1.5nm) /(In)GaAs(001) after different PMA conditions. All the samples have undergone the same PDA at 850℃ 30s in He prior to ALD-TiN deposition.

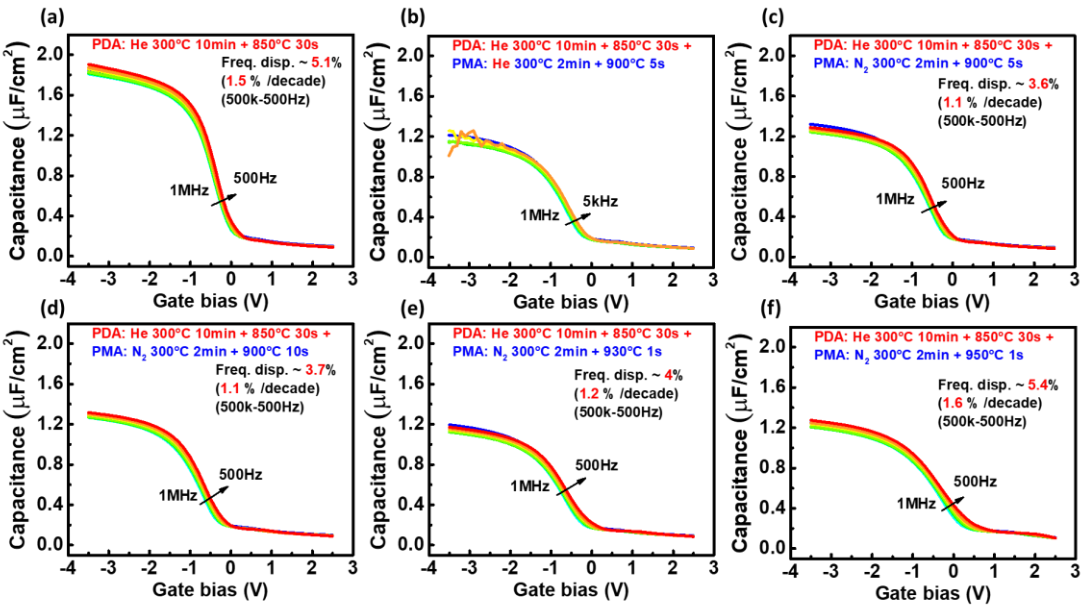

Fig. 5. C–V characteristics of Al_2O_3/ Y_2O_3/(In)GaAs(001) (a) without PMA, (b) with PMA at 900℃ 5s in He (c) with PMA at 900℃ 5s in N_2 (d) with PMA at 900℃ 10s in N_2 (e) with PMA at 930℃ 1s in N_2 and (f) with PMA at 950℃ 1s in N_2. All the samples have undergone the same PDA at 850℃ 30s in He prior to ALD-TiN deposition.

[1] Wang et al., IEEE ELECTR DEVICE L. **28**, 258 (2007)

[2] Wan *et al*., J Cryst Growth **477**, 179 (2017)

[3] Wan *et al*., Microelectron Eng. **178**, 154 (2017)

LBY and HWW have made equal contributions to this work.