A Study on Aluminum Gate La_2O_3 nMISFET with Post Metallization Anneal

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ABSTRACT

The Post Metallization Anneal (PMA) was investigated for Al gate La_2O_3 nMISFET with equivalent oxide thickness (EOT) of 1.96 nm. Conventional Post Deposition Anneal (PDA) in N_2 ambient lead to negative threshold voltage (V_{th}). Thus, this gave rise to normally-ON characteristic [1]. However, by using PMA in N_2 ambient, we had found that normally-ON characteristic was completely suppressed. Threshold voltage (V_{th}) was 0.20 V from extrapolation of I_d-V_g plot. The extracted subthreshold slope of 83.3 mV/decade suggested a fairly good interfacial quality.

EXPERIMENTS

Ultrathin La_2O_3 films (physical thickness=5 nm) were deposited on silicon substrate with isolation and source/drain structures by molecular beam epitaxy (MBE) system after surface peroxide mixture (SPM) cleaning and HF-dip processes. Pressure and temperature during the deposition were around 10^{-8}-10^{-9} Torr and 250°C, respectively. Post Metallization Anneal (PMA) in N_2 ambient was performed at 300°C for 1 min after Al gate formation. Source, drain and backside electrodes were then formed. The complete structure of nMISFET had gate length and gate width of 10 µm and 57 µm, respectively.

RESULTS AND DISCUSSION

Figure 1 shows a well behaved I_d-V_d characteristic with high drain drive (0.84 mA/µm at V_g=2 V) was observed. Normally-ON characteristic was completely suppressed with PMA annealing condition. This was later proofed that V_{th} = 0.20 V from extrapolation of I_d-V_g (Figure 2). Figure 2 shows the subthreshold characteristics of Al gate La_2O_3 nMISFET. Good subthreshold slope (*S*) with value of 83.3 mV/decade was obtained from extraction. The small swing is probably due to improved interfacial quality. Electron's field effect mobility (μ_{FE}) versus V_g-V_{th} was plotted in Figure 3. Maximum mobility of 152 cm^2/V-s was obtained. This is not as good as our previous work without PMA [2] and further optimization is necessary.

CONCLUSION

Al gate La_2O_3 nMISFET with EOT=1.96nm was fabricated and evaluated. Normally-ON characteristic was completely suppressed with the used of PMA in N_2 ambient. High drain current was observed. Threshold voltage of 0.20 V was obtained. Relatively good subthreshold swing was obtained. However, field effect mobility needs to be improved.

ACKNOWLEDGEMENT

This work was partially supported by Semiconductor Technology Academic Research Center (STARC) and Special Coordination Funds for Promoting Science and Technology by Ministry of Education, Culture, Sports, Science, and Technology, Japan.

REFERENCES

[1] A. Kuriyama et al., ECS Proceeding, 285 (2003)
[2] H. Sauddin et al., ECS Proceeding (2003)

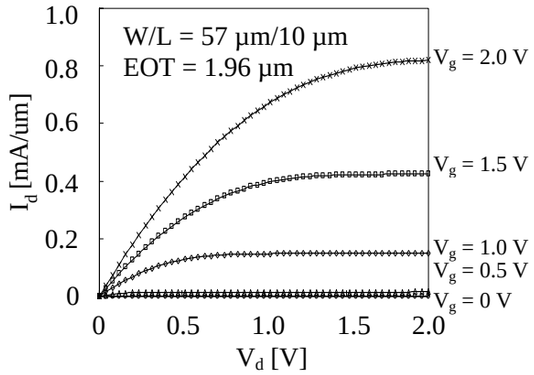

Figure 1. I_d-V_d characteristic of Al gate La_2O_3 nMISFET with PMA at 300°C in N_2 ambient for 1 min.

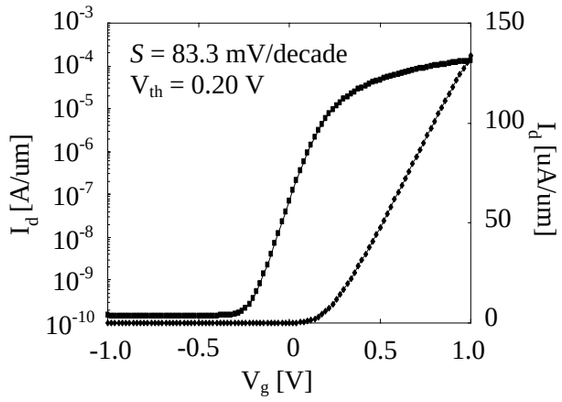

Figure 2. Subthreshold characteristics of Al gate La_2O_3 nMISFET. Subthreshold slope (*S*) and threshold voltage (V_{th}) were 83.3 mV/decade and 0.20 V respectively.

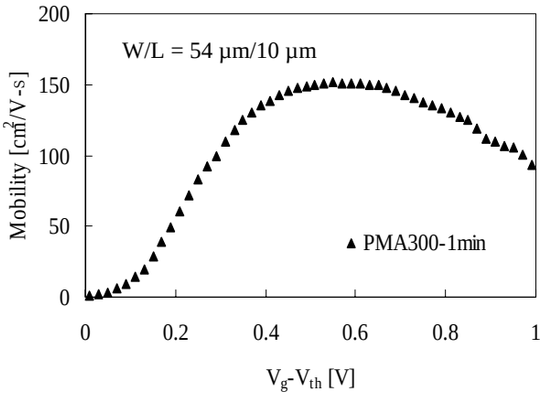

Figure 3. Electron's field effect mobility (μ_{FE}) of Al gate La_2O_3 nMISFET. Maximum μ_{FE} was 152 cm^2/V-s.