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Junction Characteristics of Oxide Barrier between Ferromagnet and Two-Dimensional Electron Gas (2-DEG)

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1. Introduction

Spin transport from a ferromagnet into a semiconductor is a major concern of spin electronic devices. Low transmission barrier is an efficient method for the spin transport, therefore oxide barrier is commonly used for the transmission layer between the ferromagnet and semiconductor. In this study we utilize a novel method for growing Al_2O_3 layer on the top of two dimensional electron gas layers. AlAs layer is deposited on insulating GaAs layer in MBE chamber without breaking vacuum and then inserted into furnace instantly.

2. Experiments

In this experiment, we utilize a novel method for growing Al_2O_3 layer on the top of two dimensional electron gas layer. The 2.7 nm-thick AlAs layer was oxidized in an open tube furnace, where water vapor was inserted with N_2 carrier gas by 100 cc/min. The sample was kept at 460 °C during 12 hours in the furnace to oxide the AlAs layer around entire sample. Finally Aluminum oxide layer is formed on the top of GaAs channel HEMT system and the schematic energy diagram is shown in Fig1.

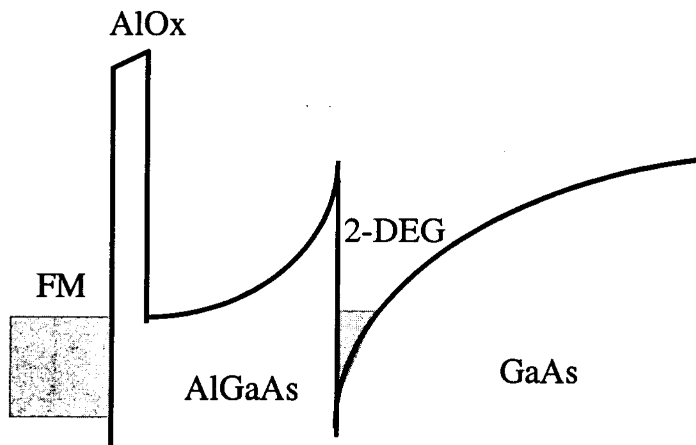

Fig1. Schematic structure of AlOx on GaAs HEMT structure

3. Results and Discussions

Fig2. shows the TEM(Tunneling Electron Microscopy) image of tunneling barrier on 2-DEG structure described earlier. As shown in the image, oxide barrier is well established.

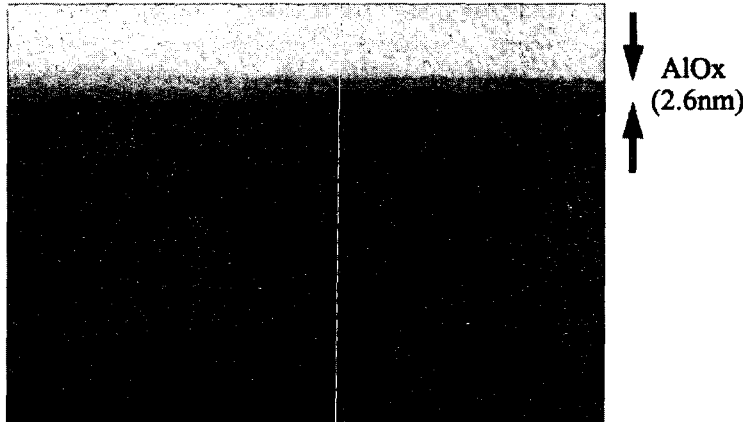

Fig2. TEM image of oxide barrier on the top of GaAs HEMT

In order to observe contact characteristic between ferromagnet and semiconductor, 60 nm of CoFe film was deposited on substrate. While voltage is applied between the two ferromagnetic electrodes, the current is measured on same electrodes. The distance between the two ferromagnet is 50 μm. Fig3. shows voltage-current characteristics. Usually CoFe-GaAs contact forms schottky barrier, but this results indicates conventional tunneling behavior. Therefore, the I-V curves clarify that Al_2O_3 layer was well formed without leakage current. AFM measurement also shows the RMS roughness is only 1.52Å.

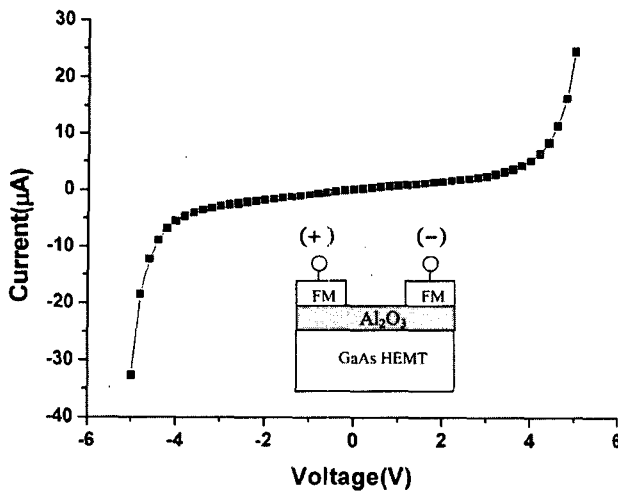

Fig3. V-I characteristics of ferromagnet-oxide-GaAs 2DEC junctions

4. References

[1] P. R. Hammar and Mark Johnson, Phys. Rev. Lett. 88, 066806 (2002)
[2] G. W. Pickrell, J. H. Epple, K. L. Chang, K. C. Hsieh, and K. Y. Cheng, Appl. Phys. Lett. 76, 2544, (2000)
[3] H. C. Koo, Hyunjung Yi, J. D. Song, J. B. Ko, Joonyeon Chang, and S. H. HAN, "A Novel Type of Spin Injection Barrier in a GaAs Based Two-Dimensional Electron Gas System,' IEEE Trans. Magnetics (in press)