Electrical Characteristics of HfO_2 and La_2O_3 Gate Dielectrics for $In_{0.53}Ga_{0.47}As$ MOS Structure

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Abstract

InGaAs MOS capacitors with HfO_2 and La_2O_3 gate dielectrics have been investigated. La_2O_3 capacitor has revealed larger capacitance value than that of HfO_2 one, owing to its high dielectric constant, at the cost of large leakage current. On the other hand, La_2O_3/HfO_2 stacking enables both the low leakage current as well as large capacitance density.

Introduction

The electron mobility of InGaAs ten times higher that of Si makes InGaAs an attractive candidate for future CMOS devices. However, the lack of highly reliable insulators on InGaAs makes it difficult to form InGaAs MOS device in contrast to Si based CMOS device.(1-4) Therefore, it is really anticipated to find out the device-quality gate insulator for InGaAs MOS device. Recently, HfO_2 and La_2O_3 are commercially used in Si CMOS devices owing to its high dielectric constant and large bandgap. In this study, we investigate electrical characteristics of $In_{0.53}Ga_{0.47}As$ MOS capacitor with HfO_2 and La_2O_3.

Experimental

InGaAs MOS capasitor were fabricated on a n-type $In_{0.53}Ga_{0.47}As$ substrate. After HF dipping, either HfO_2 or La_2O_3 were deposited by electron-beam deposition in an ultra high vacuum at a pressure of 10^{-8} Pa. Prior to aluminum metal gate deposition, post deposition annealing was conducted in forming gas at 600 ^{o}C.

Result

Figure 1 shows the gate leakage current characteristics (J_g-V_g) of the fabricated capacitors; HfO_2 single layer, La_2O_3 single layer and La_2O_3/HfO_2 stacking. La_2O_3 capacitor showed large value among the three MOS capacitor, whereas suppressed J_g can be obtained HfO_2 or stacked film. Figure 2 shows the C-V characteristics of these three MOS capacitors. La_2O_3 and La_2O_3/HfO_2 capacitors performed a large capacitance value than HfO_2 one, owing to its high dielectric constant.

Conclusion

Large leakage current through La_2O_3 was found to be suppressed by stacking La_2O_3 with HfO_2, thereby producing a large capacitance value.

Acknowlegements

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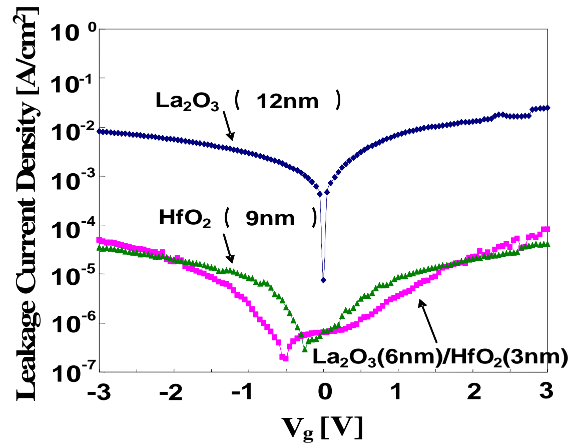

Fig.1. J_gV_g characteristics

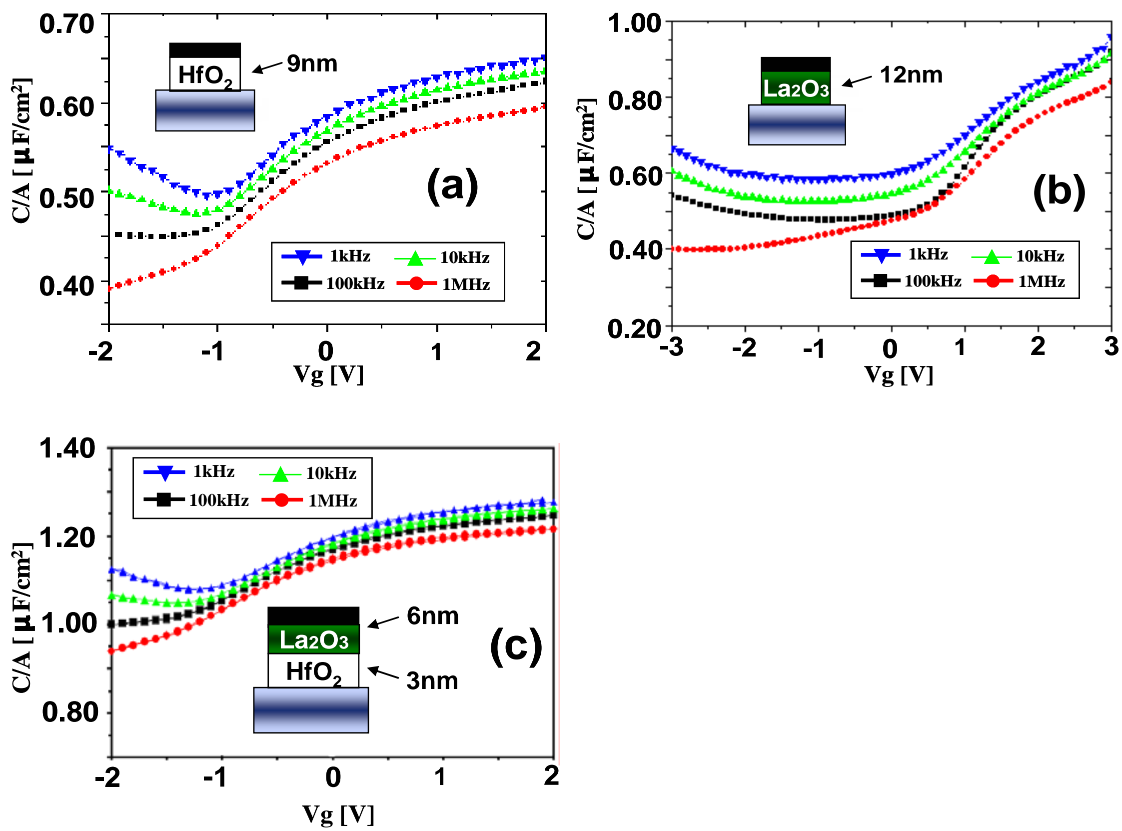

Fig. 2 CV characteristics (a) HfO_2 MOS capacitor,

(b) La_2O_3 MOS capacitor (c) La_2O_3/HfO_2 MOS capacitor