

Electrical Characteristics of HfO₂ and La₂O₃ Gate Dielectrics for In_{0.53}Ga_{0.47}As MOS Structure

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ABSTRACT

InGaAs MOS capacitors with HfO₂ and La₂O₃ gate dielectrics have been investigated. La₂O₃ capacitor has revealed larger capacitance value than that of HfO₂ one, owing to its high dielectric constant, at the cost of large leakage current. On the other hand, La₂O₃/HfO₂ stacking enables both the low leakage current as well as large capacitance density.

INTRODUCTION

InGaAs MOSFET is one of the promising candidates for next generation devices, thanks to its high electron mobility compared to that of Si. To achieve a high performing InGaAs MOSFET with low leakage current, high-k materials with proper interfacial quality should be investigated. In this work, MOS capacitors of In_{0.53}Ga_{0.47}As with HfO₂ and La₂O₃ films have been fabricated and the electrical characteristics are measured.

EXPERIMENTAL

InGaAs MOS capacitor were fabricated on a n-type In_{0.53}Ga_{0.47}As substrate, epitaxially grown on a n-type InP substrate. (Si dopant density was 5e10¹⁷ cm⁻³). After chemical cleaning with acetone and ethanol, followed by HF dipping, either HfO₂ or La₂O₃ 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 (PDA) was conducted in forming gas (H₂:3%, N₂:97%) at 600 °C. Finally, Al back contacts were formed.

RESULT

Figure 1 shows the gate leakage current characteristics (J_g-V_g) of the fabricated capacitors; HfO₂ single layer, La₂O₃ single layer and La₂O₃/HfO₂ stacking. La₂O₃ capacitor showed large value among the three MOS capacitor, whereas suppressed J_g can be obtained HfO₂ or stacked film. Figure 2 shows the C-V characteristics of these three MOS capacitors. La₂O₃ capacitor performed a large capacitance value than HfO₂ one, however, a large dispersion in capacitance value was observed. La₂O₃/HfO₂ stacked capacitor showed large capacitance as well as small frequency dispersion.

CONCLUSION

InGaAs MOS capacitors with HfO₂ and La₂O₃ gate dielectrics have been investigated. A large leakage current with La₂O₃ can be suppressed by La₂O₃/HfO₂ stacking. A large capacitance value with small frequency dispersion can be obtained with La₂O₃/HfO₂ stacking.

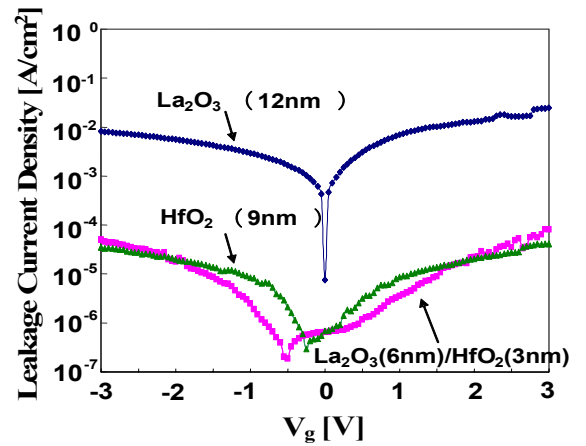


Fig.1. J_g-V_g characteristics

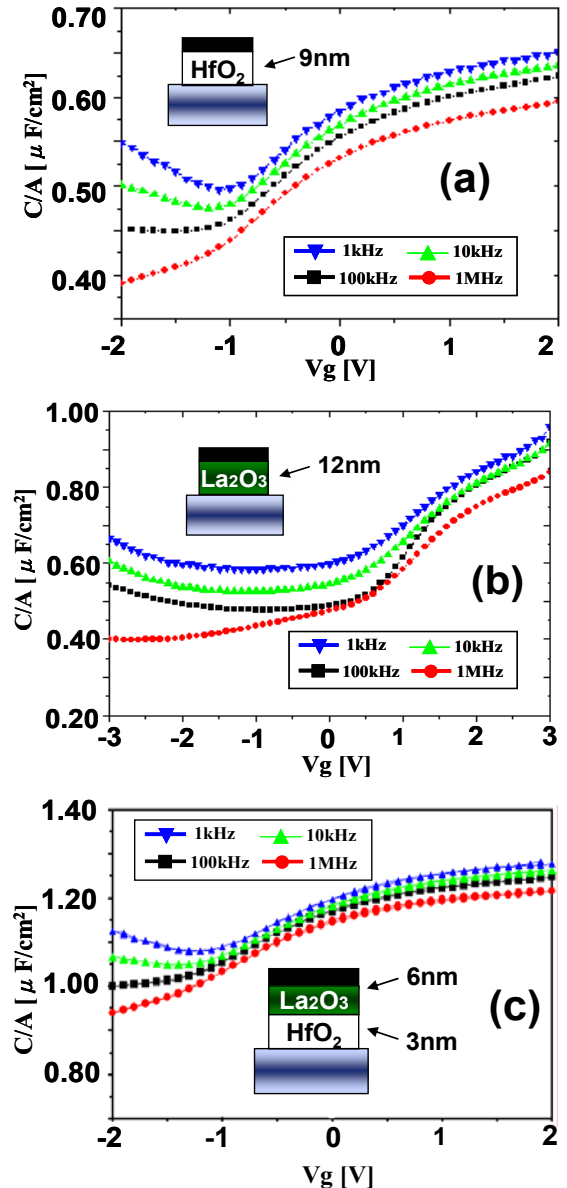


Fig. 2 CV characteristics (a) HfO₂ MOS capacitor, (b) La₂O₃ MOS capacitor (c) La₂O₃/HfO₂ MOS capacitor

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