論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	A study on AlGaN/GaN HEMT gate stacks for threshold voltage control and leakage current suppression
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出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第10270号, 授与年月日:2016年6月30日, 学位の種別:課程博士, 審査員:角嶋 邦之,筒井 一生,若林 整,渡辺 正裕,飯野 裕明
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第10270号, Conferred date:2016/6/30, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	物理電子システム創造　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（工学）
		指導教員（主）： Academic Advisor(main)	角嶋　邦之
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

AlGaN/GaN high-electron-mobility-transistor (HEMT) has been received much attention for high efficient power converter devices owing to its high electron mobility of over 1000 cm^2/Vs and high breakdown field. Recent epitaxial growth of nitride based layers have enabled AlGaN/GaN growth on Si substrates with appropriate stress relaxation buffer layers, which enables mass production on a large size wafer over 12 inches, so that high performance devices can be realized at relatively low cost. However, there are still some issues to overcome both in substrate quality and device process and reliability. One of the issues is that devices operates with normally on characteristics, which is due to the piezoelectric and spontaneous polarization of the AlGaN/GaN devices, and should be avoid in terms of fail-safe operation. On the other hand, large gate leakage current due to Schottky gate configuration limits the overdrive voltage of the devices, limiting the on-current. The thesis experimentally presents advantages of poly-Si gate electrodes and La_2O_3 gate dielectrics for shifting the threshold voltage to positive direction and for suppressing the gate leakage current.

B doped poly-Si was obtained with BF_2 ion implantation into an intrinsic poly-Si layer for gate electrode material. As there were little reaction between poly-Si and the AlGaN surface, the devices revealed high process temperature endurance with suppressed gate leakage current. By tuning the BF_2 ion implantation conditions, the threshold voltage was found to be controlled depending on the distribution of F atoms in AlGaN layer. Excess F ions near the AlGaN/GaN interface showed degraded mobility due to enhanced diffusion of F atoms at the interface, which suggests the distribution of F atom profile in the

AlGaN layer should be tailored. The poly-Si gated AlGaN/GaN HEMTs revealed high reliability against stress voltage application test over conventional Schottky gate ones.

For La_2O_3 gate dielectrics, the threshold voltage was found to shift to positive direction with higher temperature annealing. The phenomena were attributed the presence of negative fixed charges at the interface layer, reactively created between the La_2O_3 and AlGaN layers during the thermal processes. Moreover, an increase in capacitance with annealing was observed owing to the crystallization of the La_2O_3 film, which exhibit a dielectric constant of 27 when annealed over 500 ^oC. With this high k-value and the negative charges, La_2O_3 gate dielectrics have attractive physical properties to relax the trade-off performance between capacitance density and threshold voltage for AlGaN/GaN HEMT.

Finally, we investigate the prospects of poly-Si gate with La_2O_3 gate dielectrics base on the obtained experimental results. Device structures including thickness and annealing conditions for normally-off operation based on F ion distributions in the AlGaN layer with negative charges at the interface of lanthanum oxide and AlGaN layer are proposed.

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