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学位の種類	博士（工学）
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学位授与の条件	学位規則第４条第１項該当　課程博士
学位論文題目	Fabrication and characterization of ultraviolet photoresponsive devices （紫外光応答デバイスの作製とその特性評価）
論文審査委員	主査　准教授　Kalita Golap 教授　種村　眞幸 准教授　小野　晋吾 教授　河原　敏男 （中部大学）

論文内容の要旨

Ultraviolet (UV) photoresponsive devices are important component for various applications in modern day technologies. Among various wide bandgap semiconductors for UV photoresponsive devices, gallium nitride (GaN) and gallium oxide (Ga_2O_3) are significantly attractive considering their excellent electrical, chemical and mechanical properties. In this thesis work, fabrication of GaN and Ga_2O_3 based heterojunctions with graphene and p-type γ-copper iodide (γ-CuI) were investigated. The interface quality of respective fabricated devices was analyzed with and without UV illumination, which clarify the UV photoresponse properties.

Chapter 1 describes the background of UV photoresponsive devices and gives a detailed account of various structures used to fabricate devices. Then, discussed about the electrical, chemical and mechanical properties of the three-dimensional (3D) GaN and Ga_2O_3, which is used to fabricate the UV photoresponsive devices.

Chapter 2 Introduced the two-dimensional (2D) graphene material, which is integrated with GaN and Ga_2O_3 for the device fabrication. Graphene with its zero-band gap and one atom thickness is an attractive material to integrate with GaN and Ga_2O_3 to fabricate unconventional heterojunctions. The challenges in fabricating and effect of such 2D/3D heterojunction devices

are addressed, in the motivation and objective part.

Chapter 3 discussed about the UV light induced electrical hysteresis effect in graphene/GaN vertical heterojunction Schottky device. In this chapter, the interface quality of graphene/GaN heterojunction is evaluated for presence of interfacial impurities by UV light illumination. The interfacial impurities act as trap for charge carriers thus inducing electrical hysteresis in heterojunction. This finding is significant in understanding the graphene/GaN and other 2D/3D heterojunction interfaces by UV illumination process for developing high performance devices.

Chapter 4 The obtained electrical hysteresis effect in the graphene/GaN device was compared and examined by fabricating the γ-CuI/GaN heterojunction device. The fabricated device showed excellent rectifying diode characteristics with high applied bias voltage (-20V to +20 V). The device also showed excellent photovoltage of 0.93V under illumination of UV light with consistent photoresponsivity. The electrical hysteresis for γ-CuI/GaN heterojunction device was not prominent, indicating interface of graphene/GaN heterojunction device are more sensitive for UV photoresponse.

Chapter 5 discussed on the fabrication of a graphene/β-Ga_2O_3 heterojunction Schottky diode to evaluate the DUV photoresponse. The device showed rectifying diode characteristic along with photovoltaic action. The open circuit photovoltage of 10 mV was observed along with an excellent photoresponsivity of 6.1 A/W at a bias voltage of -1.5 V. Further, the interface quality of a similar heterostructure is studied with and without DUV illumination. It was observed that the interface is free of residual impurities, however the current density-voltage characteristics showed hysteresis at a higher bias voltage under the DUV illumination. The transient photoresponse showed fast photoresponse in photovoltaic mode, while significantly slower response is observed at the bias voltage considering the charge trapping/detrapping phenomena. The graphene/β-Ga_2O_3 heterojunction device also showed electrical hysteresis at a higher bias voltage, which can be corelated with the significantly sensitive graphene/GaN based heterojunctions.

Chapter 6 Conclusion and future scope of research.

Thus, this thesis demonstrates the fabrication of heterojunction devices of GaN and β-Ga_2O_3 with graphene and p-type γ-CuI, clarifying the interface properties on UV photoresponsive characteristics. This is enough worth for PhD thesis.

論文審査結果の要旨

Ultraviolet (UV) photoresponsive devices are important component for various applications in modern day technologies. Among various wide bandgap semiconductors for UV photoresponsive devices, gallium nitride (GaN) and gallium oxide (Ga_2O_3) are significantly attractive considering their excellent electrical, chemical and mechanical properties. In this thesis work, fabrication of GaN and Ga_2O_3 based heterojunctions with graphene and p-type γ-copper iodide (γ-CuI) were investigated. The interface quality of respective fabricated devices was analyzed with and without UV illumination, which clarify the UV photoresponse properties.

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