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Improvement of surface morphology and state density of 4H-SiC using r-GO as a capping layer

김성준, 김홍기, 성민제, 강민재, 최하혜, 이남석, 신훈규[a]
Seongjun Kim, Hong-Ki Kim, Min-Je Sung, Min-Jae Kang, Ha Hye Choi, Nam-Suk Lee, Hoon-Kyu Shin[a]

포항공과대학교

Abstract:

Silicon carbide (SiC) is being extensively studied for application in high power devices due to its outstanding physical properties. SiC-based devices are commonly fabricated using ion implantation since the diffusion rates of dopants into SiC are too low even at temperatures as high as 1800 °C. With ion implantation, N and B (or Al) ion implantation are used to obtain uniformly doped n-type and p-type region in 4H-SiC. To activate the implanted dopants, high annealing temperatures are necessary. However, a high temperature annealing may cause surface deterioration of the implanted layers due to the Si or SiC evaporation. A serious consequence of the roughened surface is the deleterious effects on the inversion layer mobility and specific on-resistance of SiC devices.

Many effective methods have been reported for protecting SiC surfaces during high temperature annealing. One of the expected methods is to apply a capping layer of a two-dimensional honeycomb structure having an atomic structure similar to the surface of a 4H-SiC. For example, Wang et al. have effectively improved the surface roughness and states introducing the h-BN on graphene instead of SiO_2/graphene structure. However, very few studies have been conducted on 4H-SiC material.

In this study, we investigated the improvement of surface roughness and states after high temperature annealing using reduced-graphene oxide (r-GO) capping layer. The specification of the 4H-SiC wafer used was 10 μm-thick, n-type epitaxial layer (N= 7×10^{15} cm^{-3}) grown on n-type 4° off-axis 4H-SiC. The n^+ region are formed by multiple nitrogen ion-implantations and r-GO capping layer was produced by spray coating method. AFM measurements revealed that RMS value of the sample capped with r-GO was tenfold decrease compared to the sample without r-GO capping. From the Schottky contact study, a half-decrease in surface states density was also identified estimated by ideality factor (n) – *V* curve.

Keywords

SiC, Implant, Graphene oxide, Morphology, Surface state density

a. 교신저자 이메일

shinhk@postech.ac.kr