그래핀의 엣지 접합 (Edge Contact)을 위한 플라즈마 처리 연구

Controlled Plasma Treatment for Edge Contacts of Graphene

Dewu Yue[a*], Chang-Ho Ra, Xiaochi Liu, Daeyeong, 유원종[a]
[a*]성균관대학교 나노과학기술학과 (E-mail:yoowj@skku.edu)

초 록: The applicability of graphene has been demonstrated in the electronic fields. But, high performance of graphene is limited by the contact resistance (Rc) at the metal-graphene interface. Recently, Rc was found to be improved by forming edge-contacted graphene via theoretical simulation. Based on the differences between the surface and edge contacts at the M-G interface, we demonstrate "edge-contacted" graphene through the use of a controlled plasma processing technique that generates the edge structure of the bond and significantly reduces the contact resistance. The contact resistance attained by using pre-plasma processing was of 270 Ω・μm. Mechanisms of pre-plasma process leading to low Rc was revealed by SEM and Raman spectroscopy. In the end, controlled pre-plasma processing enabled to fabricate CVD-graphene field effect transistors with an enhanced adhesion and improved carrier mobility.

1. 서론

Graphene is a two-dimensional (2D) material that exhibits unique properties. Nevertheless, the metal-graphene (M-G) interfaces have an inherent problem in that carrier transport is generally obstructed, impeding further improvements in the performance of graphene devices. Here, we explored the use of a pre-plasma process in order to enhance bonding and coupling at the M-G interface with an edge-contact configuration.

2. 본론

Pre-plasma processing for "edge-contacted" graphene that an edge contact is generated, which is the key result of this study. The plasma processing apparatus that was used to generate capacitively-coupled plasma (CCP) at a low power of 25 W with an O2 flow rate of 30 sccm. The actual working pressure of the chamber was set to 30 mTorr, and the graphene was subsequently exposed to plasma for durations of 5, 15, 25, 35, 45, 55, and 65 s. The duration of the exposure to O2 plasma increased from 15 to 45 s and resulted in a ~77% decrease in Rc. A 90% fitting confidence shows the average decreased by 71% with a lowest Rc of 270 Ω・μm, which is close to the lowest Rc reported for CVD-graphene at room temperature. We performed SEM and Ranman spectroscopy tests to elucidate the mechanism through which the proposed treatment leads to a lower Rc.

3. 결과

A process that uses oxygen pre-plasma during graphene device fabrication produced a controlled edge-contact structure that reduced Rc by as much as 77%. This controlled pre-plasma treatment is compatible with current large-scale electronic device processes, and it is therefore expected to be a baseline process for fabrication of high-performance CVD graphene and 2D devices.