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PEDOT:PSS and MoO_x doped-Reduced Graphene Oxide/Single Walled Carbon Nanotubes Hybrid Film-Based Transparent Conductive Electrodes for Light Emitting Diodes

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1. Introduction

Recently, various materials including metal oxide, metal nanowire, conducting polymer, single-walled carbon nanotube (SWNT) and graphene have been researched for transparent conductive electrodes (TCEs). Among these materials, graphene and SWNT have attracted vast attention due to its excellent optical, electrical and mechanical properties. Graphene has been prepared by several techniques; among these, reduced graphene oxide (RGO) is particularly interesting for the purpose of TCEs because it can be easily applied to large-scale display devices for low price. Even with its high electrical conductivity, as-deposited SWNT and RGO films are still below expectations due to poor dispersion of the nano materials and high junction resistances. Various doping methods such as oxygen adsorption, alkali metals, halogens to acidic liquid dopants and redox dopants have been studied to improve network conductivity; however, most of them were found to be unstable to air, chemicals, and humidity except MoO_x[1]. Lately, many researchers have made an effort to enhance the performance of GaN-based light emitting diodes (LEDs) using TCEs. Although indium tin oxide (ITO) is widely used as the TCEs for LEDs, there is a significant need for TCE for LEDs because its price is soaring [2]. In this work, we demonstrate a fabrication of GaN-based LEDs with poly(4-styrenesulfonate)(PEDOT:PSS) and MoO_x doped RGO/SWNT films as TCEs.

2. Experiment details

First, RGO and SWNT powders (1:1 w/w ratio) were immersed in a 1,2-dichlorobenzen solvent. Afterward, cleaned quartz substrates were dipped in the solution and dried with pure N_2 gas and then RGO/SWNTs films were adsorbed on the MoO_x by simple dip-coating method to optimize the optical properties of the RGO/SWNT films. The films were annealed using rapid thermal annealing (RTA) at 450℃ for 20 min in N_2. Finally the film was capped with PEDOT:PSS.

3. Conclusions

As a result, the sheet resistance decreased from 22.39 kΩ to 1.428 kΩ with a transmittance of 89.1% at 455 nm. Also, improved electrical and optical characteristics were observed for the GaN-based LEDs with the doped RGO/SWNTs films. These improvements are thought to have resulted from the gap states like oxygen vacancies between conduction band and valance band of the MoO_x and strong p-type doping effect. The results of the characteristics including performance of GaN-based LEDs will be presented at the session in detail.

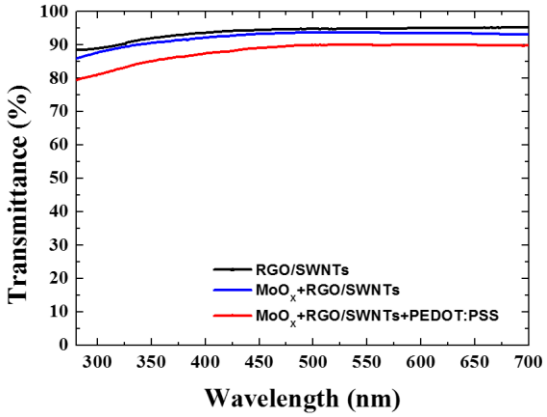

Figure 1. Optical transmittance measured for RGO/SWNT films on quartz substrates in the wavelength range from 280 to 700 nm, after MoO_x doping and PEDOT:PSS coating.

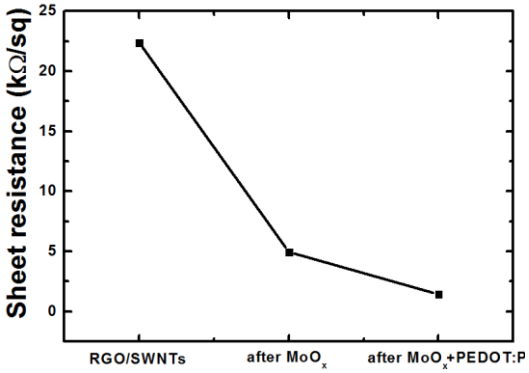

Figure 2. Sheet resistance measured for RGO/SWNT films on quartz substrate, after MoO_x doping and PEDOT:PSS coating.

References

[1] Na. S. -I, Adv. Mater. **20** (2008) 4061.
[2] Sondra L. H, Nano Lett. **12** (2012) 3574-3580