Catalyst free direct deposition of multilayer graphene on GaN by solid phase precipitation

Md. Sahab Uddin [1] and Kazuyoshi Ueno [1,2]
[1] Graduate School of Engineering and Sciences, Shibaura Institute of Technology
[2] Research Center for Green Innovation, Shibaura Institute of Technology
E-mail: nb14502@shibaura-it.ac.jp

We fabricated multilayer graphene (MLG) on n-GaN substrate directly without extra catalyst by solid phase precipitation. The characterization made by Raman Spectroscopy and SEM revealed that the MLGs produced were crystalline and crystallinity was increased with annealing temperature. With further improvement of MLG quality, this might be a method for MLG fabrication on GaN for diode application.

1. INTRODUCTION

MLG has been extensively studied for application as an active or passive layer in electronic and optoelectronic semiconductor devices due to its outstanding electrical and optical characteristics [1,2]. It was reported that graphene-GaN schottky diodes shows excellent rectifying behavior with high rectification ratio and low reverse leakage current [3]. This makes graphene a promising candidate for use as schottky rectifier in GaN semiconductor with n-type conductivity. However, graphene/MLGs were grown on Cu foil and transferred onto GaN for application in graphene-GaN schottky diodes [3]. During transferring of graphene on GaN, the PMMA contaminants may hinder the formation of a sound graphene-GaN junction, and this may be reflected in the electrical characteristics. To overcome this problem, direct deposition of graphene/MLG over GaN is preferable. We have already found that, MLG can be directly deposited on n-GaN by thermal CVD without catalyst and is already presented at JSAP [4]. In this study, we focused on direct deposition of MLG over n-GaN substrate without extra catalyst by solid phase precipitation. The structural properties of the MLGs are also presented in our present study.

2. EXPERIMENTAL

The n-GaN substrate was cleaned with IPA and TMAH and then it was dipped in hydrochloric acid to remove native oxide layers. Amorphous carbon of thickness 15 nm was deposited on cleaned GaN surface by magnetron sputtering. The sputtered structure is then annealed inside a tube furnace with temperature varies between 800 ºC to 1000 ºC in flow of Ar. The properties of the films were characterized by Raman spectroscopy and SEM.

3. RESULTS AND DISCUSSION

Figure 1 shows the Raman spectra of MLGs deposited on GaN substrate. The MLGs are characterized by D and G peaks confirms the formation of MLG. It is found from Raman spectra, the amorphous carbon of as deposited film gradually converted into MLG with increase of temperature and distinct D and G peak is observed. The G/D peak intensity ratio is increasing with increase of temperature. At high temperature GaN itself acts as catalyst for solid state reaction to occur and MLGs were produced by precipitation. The SEM photograph of the film annealed at 1000 ºC is shown in Fig. 2. From SEM photograph, smooth surface was observed for MLGs produced on n-GaN substrate.

4. CONCLUSION

We fabricated MLG directly on n-GaN substrate without extra catalyst by solid phase precipitation. However, the MLG quality is not satisfactory. Further research on improving the quality and uniformity is required.

ACKNOWLEDGEMENTS

M S Uddin is supported by Research Center for Green Innovation, SIT, Japan.

References

[1] Novoselov K. S. et al., Science, **306** (2004), 666.
[2] Geim A.K et al., Nat. Matter **6** (2007), 183.
[3] S. Kim et al., Nano Research, **8(4)** (2015), 1327.
[4] A. Enomoto et al., Ext. Abst. 76th JSAP Autumn meeting, 2015, 12-168.

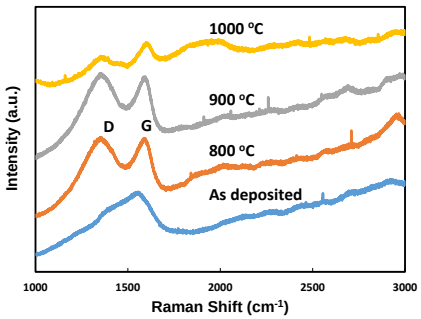

Figure 1. Raman spectra of MLG films annealed at various temperatures.

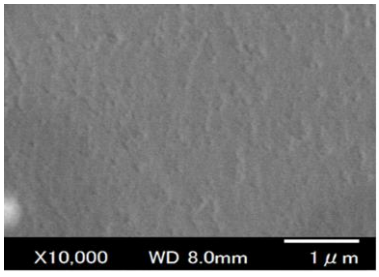

Figure 2. SEM photograph of surface of MLG film annealed at 1000 ºC.