Transferring of Graphene Obtained on Copper Foil by Chemical Vapour Deposition(CVD) Technique and Investigation of Its Optical, Structural and Characteristic Parameters

Cengiz AYKAÇ[1], Oğuzhan ÖZAKIN[2], Özkan BAYRAM[3], Betül GÜZELDİR[4] and Mustafa SAĞLAM[5]

Abstract— In this study, graphene was obtained on copper foil using methane 250/1000 sccm and hidrogene 500/1000 sccm gases by CVD technique at 1000 °C. Graphene obtained on copper foil was etched in iron chloride prepared with deionized water and rinsed in 3 different containers for half an hour. Decomposing of graphene from the copper foil was transffered from the glass and silicon substrate. And than structural, optical and chracteristical parameters of graphene was investagated. For optical, structural and characteristic properties of graphene was used respectively Uv-Vis Spectrophotometry, Atomic Force Microscopy(AFM) and Raman Spectroscopy and X-Ray Diffractometer.

Index Terms—Atomic Force Microscopy(AFM), Chemical Vapour Deposition, Graphene, Uv-Vis Spectrophotometry, Raman Spectroscopy, X-Ray Diffractometer.

1 Introduction

CVD technique is one of the best ways to obtain large area graphene. The transfer of graphene grown on copper or similar materials by CVD method is also an important step. According to the information given in the literature, graphene obtained by CVD method generally exhibits P-Type character[1].

According to the information given in the literature, graphene obtained by CVD method generally exhibits p-type character. The most effective technique in the characterization of graphene obtained by cvd method is raman spectroscopy and with this technique, much information can be obtained about the structure without damaging the sample. . The Raman spectrum of graphene is mainly characterized by D, G, and 2D peaks. The D peak is around 1350 cm−1 and is due to the breathing modes of six-atom rings and requires defects for its activation [2]. G peak is about 1585 cm−1 and corresponds to the highfrequency E2g phonon at the center of the Brillouin zone. The 2D peak at 2700 cm−1 is the D-peak overtone [3]. If there is a change in the electronic properties of the graphene, there may be changes in the intensity, width and position of the raman peaks[4]. Substrate, residual chemical species from the CVD transfer process and ambient air can induce doping in graphene. Because graphene will be in interact with iron chloride, deionized water and substrate during the transfer process, impurities may be doped into the structure. Figure 1 shows the diagram of transfer graphene during operation.

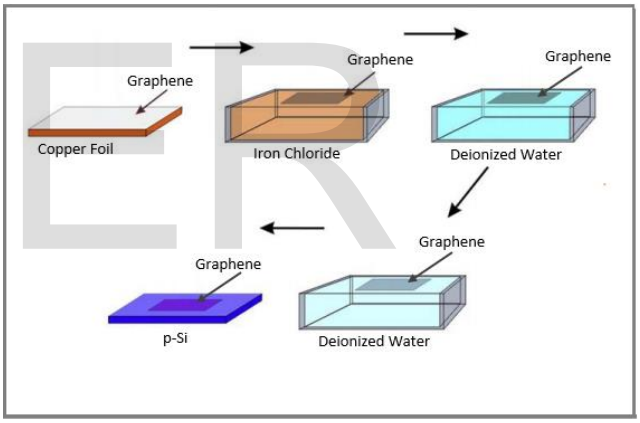

Figure 1. Schematic diagram of graphene during the transfer process, from the copper foil to the p-Si substrate.

2 Experimental

In this study, using CVD at ambient pressure few-layer graphene (FLG)samples were growth. After obtaining graphene by cvd technique, firstly, the raman measurement of graphene on copper foil was taken. Raman measurements were performed with a WITec alpha 300 R Series Raman spectrometer using a 100X objective at 532 nm. PMMA, which is generally used in the transfer process of graphene, was not used during the procedure. This is because graphene does not interfere with more chemicals. The effect of PMMA in the transfer of graphene obtained by different techniques has been expressed in different studies [6]. Graphene, which was growth on copper was placed onto the surface of a iron chloride solution(Merck, Iron Chloride hexahydrate), in order to ecth copper foil. After 15 min the structure was carefully transferred onto the surface of deionized water to clean the carbon layer

[1,4,5] *Faculty of Sciences, Atatürk University, Erzurum, Turkey, cengiz35aykac@gmail.com, bgüzeldir@atauni.edu.tr, msaglam@atauni.edu.tr*
[2] *Horasan Vocational High School, Atatürk University, Erzurum, Turkey, oguzhanozakin@atauni.edu.tr*
[3] *Faculty of Engineering, Bayburt University, Bayburt, Turkey, obayram@bayburt.edu.tr*

deposited on the copper foil. Graphene was recleaned in a different deionized water, in case the iron chloride solution could also be carried through the structure. Then, the carbon film was transfered onto finally on p-Si substrate. Graphene was placed in the oven for approximately 20 minutes to fully bond to the substrate. graphene was transferred onto glass base material for only absorbance measurements. All other measurements taken only after transfer process.

3 Results and Discussion

In our study, we tried to determine the optical and characteristic properties of graphene with four different systems such as AFM, U-V Absorption Spectroscopy, XRD and Raman spectroscopy. First, as shown in Figure 2, the assign of the graphene structure was determined by taking the raman measure. The Raman spectrum of graphite is well known [7]: there are three prominent peaks (D, G and 2D) . If you have a single-layer graphene, there should not be D peak in the spectra. Furthermore, the D peak in the raman spectrum arises from irregularly located carbon atoms in the crystal structure. In addition, the peak of the 2D band of multi-layer graphene is clearly different from that of single-layer graphene.

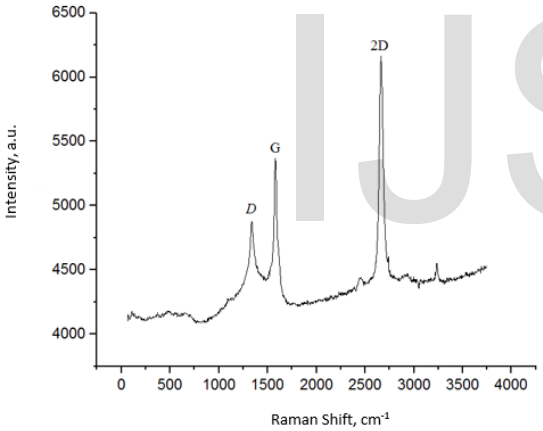

Figure 2. Raman spectra of graphene.

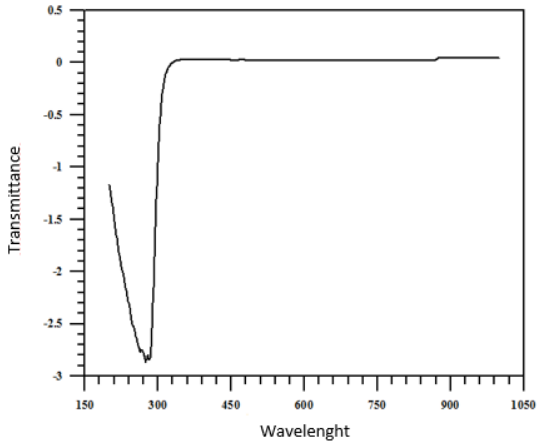

Figure 3. Uv- Vis transmiitance spectrum.

The UV-Vis transmittance spectrum of graphene films growth by CVD is shown in Figure 3 [8]. In this Figure spectrum shows an absorption peak nearly 268 nm, arising from excitons [9], and in the visible-infrared range the transmittances is almost constant for a single layer graphene, but when the number of layers increases, the transmittance varies significantly in visible region, as in [8].

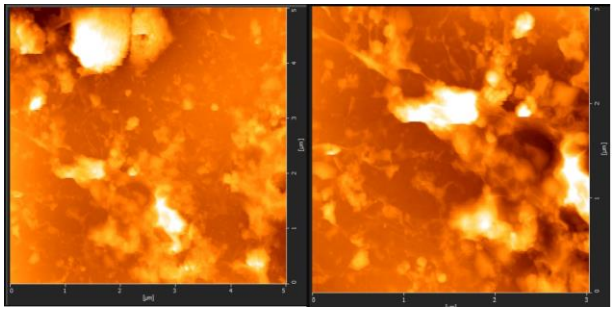

Figure 4. AFM images taken from different zone for sample.

Atomic force microscopy (AFM) is a method used to define the heights of several layers and observe the properties of the structure. It is seen from the AFM images in Figure 4 that graphene is successfully transferred onto the substrate.

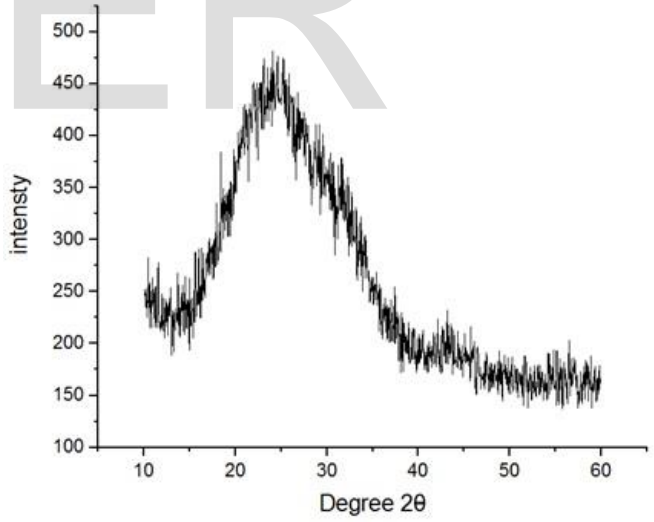

Figure 5. XRD pattern of Graphene.

XRD is an important spectroscopic technique for determining the characteristics of samples. In our study, the basis change of the xrd pattern is the defects and decays,involved in the structure during transportation. However, the characteristic peak of graphene (002)[10] is clearly observed in Figure 5.

.

4 CONCLUSION

We obtained multilayer graphene using CVD method with Methane as a carbon precursor at atmospheric pressure on Copper foil. then we moved the graphene on a different substrate to examine the structural optics and characteristic properties. From the measurements, we have successfully transferred graphene on the base material but but some deterioration was observed in this process. In the random scission of graphene, generated radicals may react with graphene defects, leading to local rehybridization of carbons from sp^2 to sp^3 on Graphene[11].

REFERENCES

[1] Horng Jet al 2011 Drude conductivity of Dirac fermions in graphene Phys. Rev. B 83 165113
[2] Ferrari A C 2007 Raman spectroscopy of graphene and graphite: disorder, electron–phonon coupling, doping and nonadiabatic effects Solid State Commun. 143 47–57
[3] Ferrari A C and Basko D M 2013 Raman spectroscopy as a versatile tool for studying the properties of graphene Nature Nanotechnol 8 235–46
[4] Das A et al 2008 Monitoring dopants by Raman scattering in an electrochemically top-gated graphene transistor Nat. Nanotechnol. 3 210–5
[5] Zhou S Y, Gweon G H, Fedorov A V, First P N, de Heer W A, Lee D H, Guinea F, Castro Neto A H and Lanzara A 2007 Substrateinduced bandgap opening in epitaxial graphene Nat. Mater. 6 770–5
[6] Lin Y C, Lu C C, Yeh C H, Jin C, Suenaga K and Chiu P W 2012 Graphene annealing: how clean can It Be? Nano Lett. 12 414–9
[7] M. S. Dresselhaus, G. Dresselhaus, R. Saito and A. Jorio, Phys. Rep. 409, 47 (2005).
[8] S. Bae, H. Kim, Y. Lee, X. Xu, J-S Park, Y. Zheng, J. Balakrishnan, T. Lei, H. R. Kim, Y. I. Song, Y-J. Kim, K. S. Kim, B. Özyilmaz, J-H Ahn, B. H. Hong and S. Iijima. "Roll-to-roll production of 30-inch graphene films for transparent electrodes", Nature Nanotech. Vol. 5, 2010, pp. 574-578.
[9] L. Yang, J. Deslippe, C-H Park, M. L. Cohen, and S. G. Louie, "Excitonic Effects on the Optical Response of Graphene and Bilayer Graphene" Phys. Rev. Lett. Vol. 103, No. 103, 2009, pp. 186802-4.
[10] Azizah N L and Susanti D 2014 Journal of Materials Engineering and Metallurgy. ISSN 2337 – 3539.
[11] Yung-Chang Lin, Chun-Chieh Lu, Chao-Huei Yeh, Chuanhong Jin, Kazu Suenaga, and Po-Wen Chiu,. 2011 American Chemical Society. Nano Lett. 2012, 12, 414−419.