Fabrication of Reduced Graphene Oxide by Electron Irradiation

Na Eun Lee, Sangyoon Lee, Hyungsan Lim and Sung Oh Cho*
Department of Nuclear and Quantum Engineering, Korea Advanced Institute of Science and Technology (KAIST),
Daehak-ro 291, Yuseong, Daejeon 34141, Republic of Korea
Author e-mail: pancy6@kaist.ac.kr

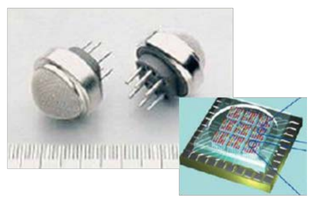
Introduction

◆Definition of graphene

- Allotropes of carbon in the form of a 2-dimensional, hexagonal lattice
- Excellent electrical conductivity (~4,000cm^2/Vs)
- High thermal conductivity (~5,000W/m•K)
- Superior light transmittance (~97.7%)
- Good Young's modulus (~1.0TPa)

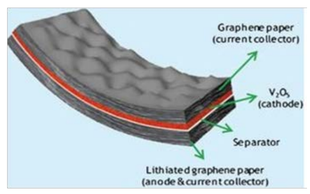
◆ Application of fluorescent Graphene

Flexible Display Touch Panel
(Organic Field Effect Transistor)



Gas/Bio sensor

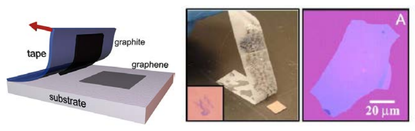
Airplane components



Graphene battery

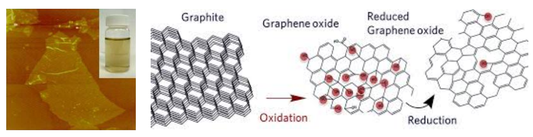
◆ Conventional methods for graphene synthesis

Mechanical exfoliation



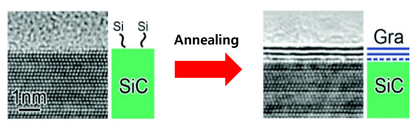
- The first physical graphene exfoliation
- Low productivity
- Low controllability

Chemical exfoliation



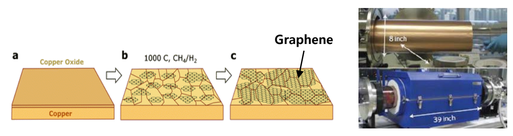
- Mass production and low cost
- Low electrical & optical quality
- Low controllability

Epitaxial Growth



- High quality
- Low productivity & high cost
- Need high temperature

Chemical Vapor Deposition (CVD)



- Good quality of graphene
- Complex transferable process
- Limited size of graphene

Graphene oxide (GO) by anodization

1. Simple process
2. Rapid synthesis
3. Green method

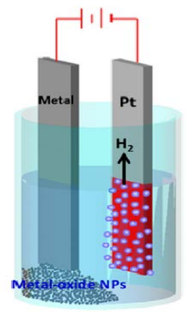
Oxygen reduction →

Reduced GO (RGO) by E-beam

1. Simple process
2. No use of harmful chemicals

Methods

① GO particles preparation



- Anode : graphite rod (1mm dia., Goodfellow)
- Voltage : 15V
- Electrolyte : 0.1-1M KCl aqueous solution
- Cathode : Platinum foil (15 × 25 × 0.2 mm^3)
- After anodization, anodized GO particles are kept in an vacuum oven at 50 ℃ overnight

② Electron irradiation on GO (E-GO)

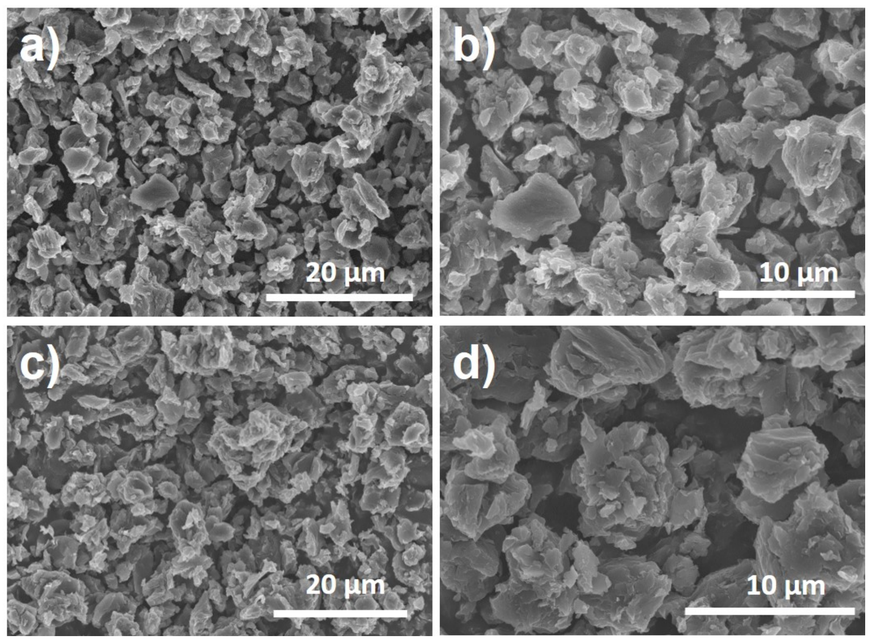
- Condition: 50keV, 0.04mA, 3hr
- Fluence: 5.37148×10^{16}cm^2

③ Characterization of GO & E-GO

- Surface morphology : SEM
- Characterization : XPS

Results & Discussion

◆ SEM image of GO and E-GO



(a),(b) SEM images of GO particles anodized at 1M KCl aqueous solution
(c),(d) TEM images of electron irradiated GO paritcles

◆ Atomic ratio of graphite powder, GO particles and E-GO particles

(at.%)	Graphite powder	GO particle	E-GO particle
C	96.48	76.5	80.56
O	3.52	23.5	19.44

- During anodization process, GO particles are detached from the graphite rod
- After the electron irradiation, shape and size of E-GO particles are not highly changed
- After the anodization, oxygen content in GO increased rapidly to 23.5 at%
- After the electron irradiation, oxygen content of E-GO slightly reduced and it is induced by crosslinking of GO by electron beam

Conclusion

- RGO particles are fabricated by anodization and electron irradiation
- GO particles are prepared by anodization of graphite rod in KCl aqueous solution
- Morphologies and size of E-GO are not changed by electron beam
- After E-beam irradiation, oxygen contents of E-GO are slightly reduced

Acknowledgements

- This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (No. 2020M2D8A2069727).