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Effect of Gamma-Ray and Electron Beam Irradiation on Reduction of Graphene Oxide Suspension in Aqueous Alcoholic Solution

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Enormous scientific and technological progress has been in the application of graphene, since its unique properties were unearthed by Andre Geim and Konstantin Novoselov in 2004. To realize the commercialization of graphene, the cost-effective and scalable production has been of great important and still considered as one of key issues in the graphene community. In this context, the wet chemical method based on the reduction of graphene oxide (GO) has been the most popular way to produce graphene because it probably offers large scalability and production of solution-processable graphene that can facilitate its many applications. Thus, numerous chemical reducing agents-, heat-, and light-based reduction strategies has been numerously exploited. However, these strategies have such drawbacks such as a necessity of toxic and explosive reducing agents, high temperature processing, and less scalability. Hence, there still is a high demand for the development of a cost-effective and large-scale method.
This research was aimed to investigate the reduction of GO suspension in aqueous ethanol (EtOH) through gamma-ray or electron beam (EB) irradiation with discriminable advantages as no need of reducing agent, room-temperature processing, and mass-producibility. For radiation-reduction of GO, a solution of GO suspension in 50 v/v% EtOH/water (H2O) prepared by diluting a 5 mg/ml GO solution in H2O was added to glass vial, sealed with a rubber septum, and purged with nitrogen gas. The resulting vials containing the GO suspension were irradiated at room temperature by gamma-rays from a Co source or EB from a 10 MeV UELV-10-10S electron accelerator located at Korea Atomic Energy Research Institute at the various absorbed doses ranging from 50 ˜ 100 kGy. The dose rate for gamma-ray irradiation was 10 kGy and the scan rate for the EB irradiation was 10 kGy/min. The resulting reduced GOs (rGO) were systematically characterized in terms of optical, chemical, thermal, morphological and electrical properties.
From the results of UV-Vis, FT-IR, TGA, and TEM analyses, it is clearly confirmed that GO suspension in aqueous EtOH was effectively reduced by gamma-ray and EB irradiation, and the thermal, chemical, and thermal properties of the resulting rGO was dependant on the absorbed. Noticeably, on the basis of the results of the electrical conductivity measurement, the rGO prepared by the EB irradiation exhibited similar magnitude of the electrical conductivity to that prepared by the gamma-ray irradiation at the same absorbed dose, indicating that the EB irradiation can reduce GO more quickly than the gamma-ray irradiation.
In conclusion, the reduction of GO suspension in aqueous EtOH can be successfully achieved by both gamma-ray gay and EB-irradiation. More importantly, EB-based reduction is much faster than the gamma-ray irradiation. Therefore, this EB-irradiation reduction is promising for the cost-effective and large-scalable production of graphene.

Country/Organization invited to participate

Korea, Republic of

Primary author: Mr JUNG, Chan-Hee (Korea Atomic Energy Research Institute, Korea, Republic of)

Co-authors: Mr HWANG, In-Tae (Korea Atomic Energy Research Institute, Korea, Republic of); Ms SOHN, Joon-Yong (Korea Atomic Energy Research Institute, Korea, Republic of); Mr SHIN, Junhwa (Korea Atomic Energy Research Institute, Korea, Republic of); Mr YU, Seungho (Korea Atomic Energy Research Institute, Korea, Republic of)

Presenter: Mr YU, Seungho (Korea Atomic Energy Research Institute, Korea, Republic of)

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