Efficient and Controlled Preparation of Graphene-Based Materials and Their Application for Water Purification

Yuta Nishina[a]*

[a] Research Core for Interdisciplinary Sciences, Okayama University, Japan

*Corresponding author: nisina-y@cc.okayama-u.ac.jp, +81-86-251-8718

Abstract: Despite the outstanding properties of graphene-based materials, many obstacles must be overcome for practical use. The biggest challenge is establishing a method for producing high-quality graphene materials on a large scale and with good reproducibility at a low cost. Currently, there is a trade-off between cost and physical properties; thus, we are required to select an optimum preparation method for graphene depending on the application.

In this presentation, graphene oxide (GO) obtained by oxidizing and exfoliating graphite is introduced as an example. We have achieved a 500 g scale production of GO in the laboratory, and 10 kg production in a prototype plant by optimized oxidation method using $KMnO_4$ in H_2SO_4. These large-scale productions were achieved by the mechanistic study of the oxidation process using in situ analyses, such as XRD and XANES. Our optimized GO production processes enabled the control of the size, oxidation degree, and functional group distribution on GO. Furthermore, the electrochemical oxidation of a graphite electrode has recently attracted considerable attention because it does not require any oxidant or concentrated sulfuric acid. GO produced through the existing electrochemical method is generally lacking in quality, due to the non-uniform destruction of the intermediately oxidized graphite. We developed a method for the non-destructive oxidation of graphite using a specially designed electrolyte. Compared to chemically generated GO, the electrochemically generated GO exhibits similar or better physical and chemical properties. This electrochemical method is also applicable to a continuous flow system, thus promising the mass production of GO for future industrialization. Functionalization of GO for water purification applications is also disclosed in the presentation.

Keywords: graphene oxide, water purification