

Name TSUGAWA Tatsuki	Job Title Assistant Professor	Area of Expertise Inorganic Materials Chemistry
-------------------------	----------------------------------	--

1. Main Research Topics

2D materials possess a high aspect ratio relative to their molecular-scale thickness and exhibit unique properties distinct from those of conventional bulk materials. These characteristics enable structural control and functional design at the nanoscale, and are expected to be applied in a wide range of applications, including next-generation electronic devices, electrodes, and sensors. In this study, we focus on the development of graphene oxide (GO) –based materials and promote research ranging from fundamental studies to applications in the environmental and energy fields.

① Functionalization of Graphene Oxide via Control of Oxygen Functional Groups

GO is obtained by oxidizing graphite powder followed by exfoliation into single layers (Fig. 1). This material contains various oxygen functional groups, such as hydroxy, epoxy, carbonyl, and carboxy groups, which impart diverse properties. In this study, we aim to develop high-performance functional materials by controlling the composition of oxygen functional groups introduced during the oxidation process, thereby optimizing the material properties according to specific applications.

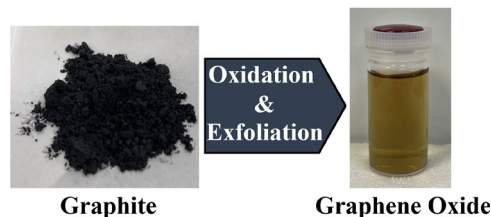


Fig. 1 Flowchart for the synthesis of GO

② Development of Multifunctional Membranes Using 2D Materials

2D materials, including GO, exhibit excellent dispersibility in solvents and enable the formation of uniform, large-area film formation via solution processes such as spin coating and vacuum filtration. Furthermore, by controlling defect density, interlayer spacing, interfaces, and the degree of oxidation/reduction, it is possible to impart a variety of functionalities, including selective permeability for molecules and ions, superior barrier property, proton conductivity, and electrical conductivity.

In this study, we design and laminated membranes based on these 2D materials, aiming not only to achieve high selectivity in ion and gas separation membranes, but also to develop anticorrosion coating films, transparent conductive films that combine optical transparency and electrical conductivity, and solid electrolyte membranes for high-performance fuel cells (Fig. 2). Through these efforts, we aim to contribute to the development of high-performance devices in the environmental and energy fields.

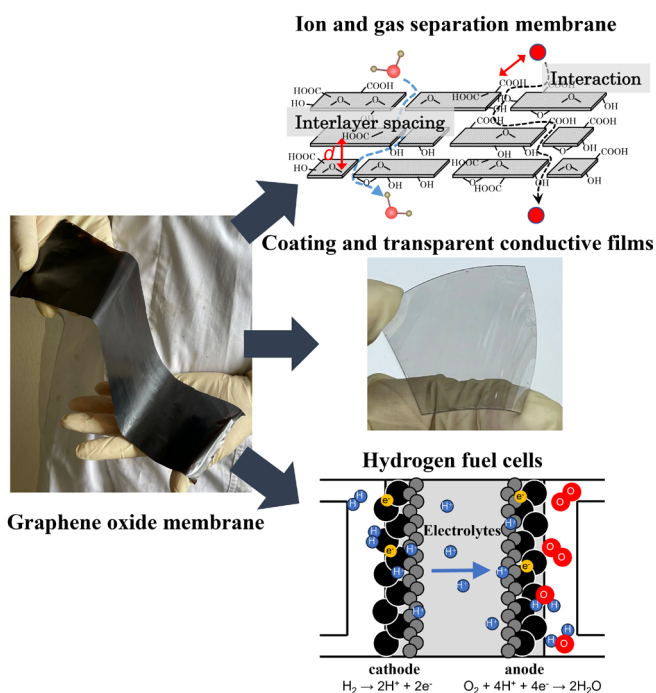


Fig. 2 Applications of GO membranes

2. Keywords

Graphene oxide, 2D materials, Proton conductivity, Barrier membrane, Separation membrane, Transparent conductive film, Hydrogen fuel cells

3. Remarks and Websites

We focus on the functionalization of graphene oxide through nanostructure control, integrating material synthesis, structural characterization, property evaluation, and device applications. We aim to advance sustainable carbon materials science and promote practical implementation in the environmental and energy sectors through industry collaboration.

researchmap: <https://researchmap.jp/21039357-TSUGAWA>

Laboratory: <https://www.cms.nagasaki-u.ac.jp/lab/zaika/zak.htm>