



Nanoprotonics : Design of Materials Interface by Highly-Proton Conductive Organized Polymers

Skills and background we are looking for in prospective students

Our group respects your various research backgrounds. While valuing your learning that you have studied so far, you are required to have a high motivation to keep you motivated to tackle new research.

What you can expect to learn in this laboratory

Through twice a week seminars conducted in English, specifically research discussion and literature introduction, you will acquire the ability to examine and think oneself, with the help of supervisor and seniors. As a practice opportunity, you will study on polymer chemistry, surface chemistry, electrochemistry, coordination chemistry etc. You also acquire following things. 1. Problem discovery and solution method. 2. Material synthesis and various analytical methods. 3. Interpretation method of data based on logical thinking and presentation skill.

[Job category of graduates]

University faculty in home country, Chemical company, Energy company

Research outline

Protonics is based on integrated sciences and technology for utilizing hydrogen atoms and molecule, hydrogen radical, proton (hydron), and hydride. It can contribute to the future hydrogen society through fuel cells, which are one of the ideal power sources for the next generations.

Since we found enhancement phenomena of the proton transport in the confined polymer thin films (so-called Nanoprotonics) on 2008, our group develops highly proton-conductive polymers for the energy devices by our own concept. Our interest is to investigate the relation between the polymer organized structures and high proton transport property. A well known Nafion for a high proton conductive polymer is a less ordered structure, however, our group has developed some highly proton-conductive organized polymers with both the confined space and organized structure. With many collaboration to international universities, institutes and companies, we are challenging to develop future technologies for not only fuel cells but also related energy sectors to create science and technology of Protonics.

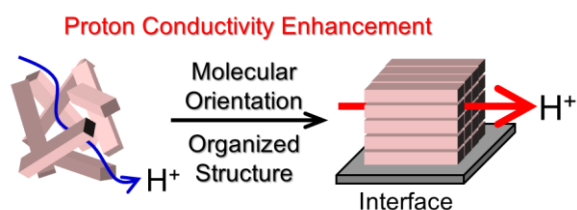


Fig. 1 Proton conductivity enhancement by molecular structure and organized structure using interface. This concept can be applicable to the ionomers of polymer electrolyte fuel cells.

Research Themes

1. Organized Polymers for Fuel Cell Ionomers (H^+ / OH^-)
2. Metal-Organic Coordination Network Thin Films for Fuel Cell and Solar Cell
3. Cross-linked Organic Thin Films
4. Pt-Free Electrochemical Catalysts for Fuel Cells

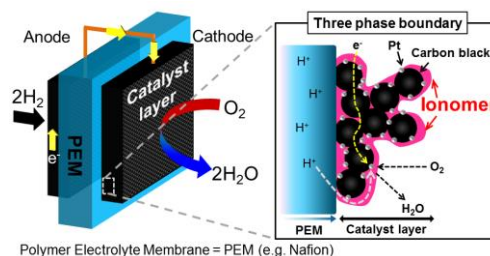


Fig. 2 Schematic view of polymer electrolyte fuel cell. Our group investigates the ionomer part to enhance proton- or hydroxide-transport property.

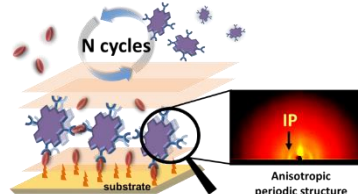


Fig. 3 Schematic view of synthesis of metal-organic coordination network thin films by humidity controlled layer-by-layer technique. Our group designs novel polymer structures for fuel cells and solar cells using the interface.

Key publications

1. Y. Nagao, Proton-Conductivity Enhancement in Polymer Thin Films (Invited Feature Article), *Langmuir*, **33**, 12547 - 12558 (2017).
2. Y. Ono, R. Goto, M. Hara, S. Nagano, T. Abe, Y. Nagao, High proton conduction of organized sulfonated polyimide thin films with planar and bent backbones, *Macromolecules*, **51**, 3351 - 3359 (2018).
3. Y. Ono, Y. Nagao, Interfacial Structure and Proton Conductivity of Nafion at the Pt-deposited Surface, *Langmuir*, **32**, 352 - 358 (2016).

Equipment

Humidity controlled in-situ impedance, IR, and QCM. UV-vis, GPC, Electrochemical analyzer, RF sputter, Inkjet, Fuel cell test, Plasma system etc. In-situ GISAXS and NR are available as collaborations.

Research and teaching policy

Our research group has a lab core time from 9 am to 17 pm. I need only one promise with you before acceptance. I expect you not to be later than 9 am. I would instruct you to acquire the ability to efficient plan and carry out experiments effectively. Studying hard is necessary to success but well organized planning is much more important to save your time. Please refresh on weekend, holiday and vacation.

[Website] URL : <http://www.jaist.ac.jp/ms/labs/nagao-www/?lang=en>