Contribution ID: **585** Type: **Oral Presentation**

Ex-situ visualization of wetting dynamics in a microporous layer of polymer electrolyte fuel cells by X-ray computed tomography under water vapor supply

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The cell potential of polymer electrolyte fuel cells (PEFCs) is reduced by accumulation of liquid water in the cathode gas diffusion layers (GDLs). The GDL is usually composed of a substrate (i.e., carbon paper) and a microporous layer (MPL). The MPLs are usually made of carbon nanoparticles and fluoropolymers. It is well known that MPLs suppress water accumulation in the GDL. Water accumulation in the MPL is conventionally observed by operando (during the measurement of the performance) X-ray radiography. The obtained results are the one-dimensional average saturation in the X-ray incidence direction. For example, if the water distribution in the MPL is heterogeneous, this cannot be observed by Operando X-ray radiography. Therefore, three-dimensional information of water distribution can help understand water behavior in the MPL. Operando X-ray computed tomography (CT) is a powerful tool to visualize 3D water distribution in the substrate. The method is, however, difficult to visualize 3D water distribution in the MPL because the CT image of the MPL near the catalyst layer (CL) is blurred by strong X-ray absorption by Pt loaded in the CL.
We developed an ex-situ method for visualizing the 3D distribution of the wet domain in the MPL[1]. The sample was a punched GDL without a CL to circumvent the problem in the Operando X-ray CT mentioned above. A GDL with an MPL was cooled down in a wet atmosphere so that water vapor could condense in the pores of the MPL. X-ray CT scanned the wet domain in the MPL. The visualization results revealed that the wet and dry domains coexisted in the MPL. In addition, the liquid water distribution in the through-plane direction indicated that liquid water formed in the MPL drained to the substrate side and the outer surface side. The dynamic behavior of liquid water, however, could not be analyzed because it took 6 minutes to conduct a CT scan.
Here, we report the dynamic behavior of the wet domain in the MPL. Wet domain in the MPL was produced similarly to the previously reported method. A series of CT images were scanned with a time resolution of 4 seconds. With supplying water vapor, the average volume of the wet domain increased, and the number of wet domains decreased. This means that wet domains expanded by absorbing water vapor and combined. The wet domains finally reached the outer surface of the MPL and covered 20% of the area. This two-dimensional wet area may hinder oxygen transport at the MPL –CL interface.

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Country

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References

[1] Satoru Kato, Satoshi Yamaguchi, Wataru Yoshimune, Yoriko Matsuoka, Akihiko Kato, Yasutaka Nagai, Takahisa Suzuki, “Ex-situ visualization of the wet domain in the microporous layer in a polymer electrolyte fuel cell by X-ray computed tomography under water vapor supply”, Electrochemistry Communications, 111 (2020) 106644.

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Unsure

Primary authors: Dr KATO, Satoru (TOYOTA Central R&D Labs., Inc.); Mr YAMAGUCHI„ Satoshi (TOYOTA Central R&D Labs., Inc.); Ms MATSUOKA, Yoriko (TOYOTA Central R&D Labs., Inc.); Mr KATO, Akihiko (TOYOTA Central R&D Labs., Inc.); Dr NAGAI, Yasutaka (TOYOTA Central R&D Labs., Inc.); Mr SUZUKI, Takahisa (TOYOTA Central R&D Labs., Inc.)

Presenter: Dr KATO, Satoru (TOYOTA Central R&D Labs., Inc.)

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