Activities of the PEFC Evaluation and Analysis Platform initiative

- NEDO Innovative FC−MEA evaluation and analysis -

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Based on scenarios outlined in the revised Hydrogen Basic Plan and the Hydrogen and Fuel Cell Strategic Roadmap, revised in 2025, the NEDO "Industry-Academia-Government Collaborative Research and Development Project for Dramatically Expanding Fuel Cell Utilization" (Innovative FC Project) has been implemented since 2020 with the aim of strengthening the competitiveness of Japan's fuel cell technology, which was the first in the world to be introduced to the market, and establishing a firm position in the global market. This project aims to develop foundational technologies in collaborative areas based on user needs to realize highly efficient, highly durable, and low-cost fuel cell systems (including hydrogen storage tanks, etc.) that will contribute to the independent widespread adoption of fuel cells from 2030 onward.

The PEFC Evaluation and Analysis Platform (PEFC-PF) was conceived at the start of the Innovative FC Project and continues to operate today. As shown in Figure 1, the organization is comprised of five research and development groups: the Management Group, the Simulation Group, the Materials Analysis Group, the Electrochemical Evaluation Group, and the Materials Informatics Group. Aiming to contribute to collaboration between academia, government, and industry, it organizes the development challenges of high-efficiency, high-durability, and low-cost fuel cells, establishes a technological foundation based on industry demands, and disseminates information on research and global trends. It also formulates a common evaluation protocol and proposes clear evaluation criteria and improvement strategies to materials developers. This initiative organizes the challenges set forth in the roadmap of the Innovative FC Project, which was implemented over five years starting in 2020.

In particular, the "NEDO Innovative FC MEA" (hereinafter referred to as NEDO-MEA), which combines the various elements constituting the Membrane Electrode Assembly (MEA), demonstrated the progress toward the target, and raised issues arising from the combination of these elements, as well as challenges related to high-temperature operation as outlined in the next 2035 roadmap.

To understand the project's progress and identify future challenges, electrochemical evaluation and material analysis were conducted on example combinations of research materials. Each element was sourced from research materials identified within the project, with the cooperation of businesses capable of producing sufficient quantities for process study and optimization. Ionomer ratios and dispersion conditions were investigated to maximize the performance of the research catalysts. Evaluation was performed using a 1cm x 3cm uniform field cell, commonly used for material property analysis, in accordance with the NEDO evaluation protocol (80°C, 75%RH, 150kPaG). Cell evaluation at 120°C, the target of the 2035 roadmap, was also conducted. To clarify the differences in characteristics between the standard MEA and the NEDO-MEA, a detailed analysis focusing on the catalyst layer structure was performed. HOPI manufactured by AGC Inc. was used as the ionomer for the NEDO-MEA.

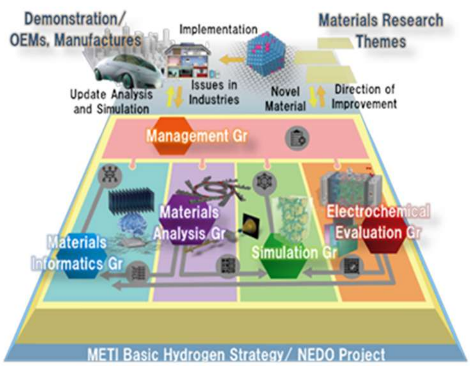

Fig. 1. Configuration diagram of PEFC-PF

Figure 2 shows the IV performance under 80°C, 75%RH, and 150kPaG conditions. The NEDO-MEA achieved higher voltage results compared to the standard MEA across the entire current density range. Detailed electrochemical diagnostics revealed that the catalyst mass activity was 3.5 times higher, ECSA was twice as high, catalyst layer resistance was 1/5, and oxygen diffusion resistance was 1/2. Through performance improvements to each component and optimization of their combinations, a voltage increase of approximately 100 mV was achieved at 3 A/cm², roughly meeting the 2030 target.

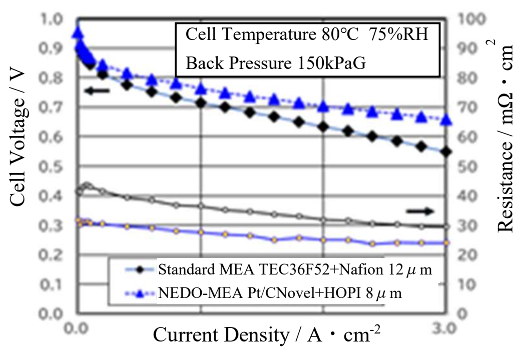

Fig. 2. IV performance of MEA

By advanced analysis, we confirmed a correlation between the small catalyst particle size and large ECSA of NEDO-MEA. Ionomer was not observed within the support, suggesting increased mass activity due to suppression of sulfur poisoning around the Pt. Furthermore, 3D-TEM observation confirmed that while standard MEA showed Pt and ionomer distributed only on the support surface, NEDO-MEA also contained Pt within the support.Cross-sectional SEM observation revealed that the catalyst layer of NEDO-MEA contained a scattering of relatively large pores, with significant variations in pore size density and structural porosity.

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