Contribution ID: **860** Type: **Poster Presentation**

Covalent Organic Frameworks Supported Highly Active Fe-N-C Catalyst Boosting Oxygen Reduction in Direct Formate Fuel Cell

Monday, 13 May 2024 14:55 (1h 30m)

Direct liquid fuel cells have become an ideal power source for rapidly emerging miniaturized and portable electronic products due to their advantages of cleanliness, environmental friendly, high efficiency, safety, long endurance, and fast “charging”. However, at present, the cathode catalysts for oxygen reduction reaction (ORR) of such fuel cell are still mainly platinum or platinum-group noble metals, which leads to the high cost. In addition, these precious catalysts may be poisoned and inactivated during the operation of the fuel cell, seriously affecting the output performance and stability.
In recent year, covalent organic frameworks (COFs) have emerged as a potential materials for energy storage and electrochemistry conversion due to their high porosity, atomically precise structures and designable topological architectures. Thus, COFs material was synthesized in this study to serve as the support for FePc by facilely sovolthermal process, forming highly active Fe-N-C catalyst to boost ORR in direct formate fuel cell (Fig. 1a). Different load of FePc into COFs (Fig. 1b) was investigated and one could see that the most active COFs-supported catalyst (FePc1@COFs5) exhibited higher onset potential of 0.929 V (vs. RHE) and half wave potential of 0.862 V (vs. RHE) than that of commercial Pt/C (0.928 and 0.845 V (vs. RHE)) (Fig. 1c). Further, the direct formate fuel cell with FePc1@COFs5-coated cathode also archived higher power density and limiting current than that with Pt/C catalyst (Fig. 1d). The facile synthesis process and high performance of COFs-supported catalyst broaden the development for COFs application in electrochemistry energy conversion.

Fig. 1 (Seen in attachment) (a) Schematic illustration of membrane-free direct formate fuel cell with Pd-deposited Ti mesh anode and COFs-supported catalyst-coated air cathode, (b) Fe content in different samples, (c) Linear sweep voltammetry scanning for different samples in 0.1 M KOH by scanning rate of 10 mV/s, (d) power density curves of membrane-free direct formate fuel cells with 2 mg/cm2 Pt/C-coated cathode and 2 mg/cm2 COFs-supported catalyst-coated cathode.

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Session Classification: Poster

Track Classification: (MS04) Swelling and shrinking porous media