PEFC 酸素還元反応用カーボンフリーナノ粒子連結触媒の開発

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Carbon-Free Connected Nanoparticle Catalysts for Oxygen Reduction Reaction in PEFCs
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To expand the applications of PEFCs, the improvement of the activity and durability of cathode electrocatalysts for oxygen reduction reaction (ORR) is essential. The conventional ORR catalyst (Pt/C) consists of Pt nanoparticles supported on carbon black (Fig. 1a), which shows low ORR activity as well as low durability due to the dissolution and agglomeration of Pt nanoparticles and carbon corrosion during PEFC operations. Our group has developed a carbon-free connected nanoparticle catalyst for ORR, which consists of nanonetwork formed by the connection of Pt-based nanoparticles (Fig. 1b).[1)] The metal nanonetwork possesses high electrical conductivity, leading to the elimination of carbon supports. As shown in Fig. 1c, the ORR specific activity of the connected Pt–Fe catalyst is about 10 times higher than that of Pt/C. Furthermore, the connected Pt–Fe catalyst with a carbon-free structure and a high superlattice degree provides high durability against PEFC operations (start/stop and load cycles).

Keywords : Fuel Cell; Nanonetwork; Platinum-Based Catalyst; Activity; Durability

固体高分子形燃料電池(PEFC)の普及拡大には、酸素還元反応(ORR)触媒の高活性・高耐久化が必要不可欠である。Pt ナノ粒子がカーボン上に担持された従来の ORR 触媒(Pt/C, Fig. 1a)は、ORR 活性が低く、PEFC 運転時に Pt ナノ粒子の溶出・凝集やカーボンの腐食が起こり、電池性能が劇的に低下する。本グループは、新たな ORR 触媒として、Pt 系ナノ粒子が連結したナノネットワークで構成されるカーボンフリーナノ粒子連結触媒(Fig. 1b)を開発した[1)]。金属ナノネットワークは導電性を有するため、カーボン担体を必要としない。開発した超格子 Pt–Fe ナノ粒子連結触媒は、市販の Pt/C よりも約 10 倍高い ORR 表面比活性を示す(Fig. 1c)。さらに、カーボンフリーかつ高い超格子化度を有する本触媒は、燃料電池(起動停止・負荷応答)運転に対する高耐久性を実現できる。

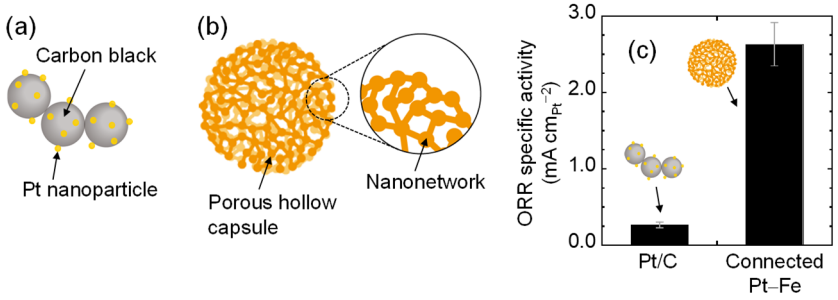

Fig. 1. Schematics of (a) conventional Pt/C and (b) carbon-free connected nanoparticle catalysts. (c) Comparison of ORR specific activity of the catalysts.

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1) T. Yamaguchi *et al.*, *Energy Environ. Sci.*, **2015**, *8*, 3545, *ACS Appl. Nano Mater.*, **2020**, *3*, 9912.