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Narrow size distribution of Pt nanoparticles covered by an S-doped carbon layer for an improved oxygen reduction reaction in fuel cells

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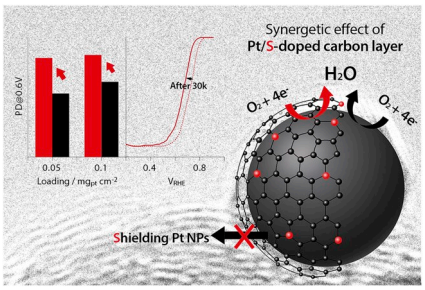
HIGHLIGHTS

- Improved activity toward oxygen reduction on Pt NPs covered by S-doped carbon layer.
- Surfactant fosters both uniform Pt distribution and creation of a thin carbon layer.
- High PEMFC performance with ultra-low Pt incorporated in S-doped carbon layer.

GRAPHICAL ABSTRACT



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ABSTRACT

Proton exchange membrane fuel cells (PEMFCs) attract immense interest recently; however, the activity and usage amount of the Pt nanoparticles therein pose limitations to their application. We synthesize highly active and durable Pt nanoparticles for the electrocatalytic oxygen reduction reaction (ORR) in fuel cells. In the presence of an S-containing surfactant during the synthesis, the Pt nanoparticles are strongly anchored to the catalyst support, which results in narrow size distribution. Successive heat treatment under reducing conditions provides an S-doped carbon structure as a functional layer of Pt/C, thereby enhancing the durability. The functional layers are able to facilitate the rate-determining step of the ORR by lowering the OOH coverage. The PEMFC power density similar to that of pristine Pt/C achieves using only half Pt amount at the cathode due to the synergetic effect of Pt and S-doped carbon.

1. Introduction

With the development of fuel cell vehicles, proton exchange membrane fuel cells (PEMFCs) have attracted considerable attention owing to their numerous advantages, such as high power density, fast start-up and low working temperature. However, some limitations still remain, such as the high price of Pt group metals (PGM) and low durability owing to the Pt dissolution [1] and carbon corrosion phenomena [1,2], especially at the cathode. A variety of structures such as M-Pt bimetallic core-shells and shape-controlled hollow Pt nanostructures have been suggested as highly active low-Pt catalysts for oxygen reduction reaction (ORR). Recent studies have investigated the relationship between the

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