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Short communication

Platinum supported on functionalized ordered mesoporous carbon as electrocatalyst for direct methanol fuel cells☆

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Abstract

Ordered mesoporous carbon (OMC) with a specific area of 570 $m^2\ g^{-1}$ was synthesised using mesoporous silica SBA-15 as template. OMC was used as platinum catalyst support using the method of reduction with $NaBH_4$. Before deposition of platinum, the texture and surface chemistry of the support were modified by oxidation treatments in liquid phase using nitric acid as oxidative agent. During the oxidation process, oxygen surface groups were created, whereas ordered porous structure was maintained, as temperature programmed desorption and transmission electronic microscopy showed, respectively. Platinum supported materials were well dispersed over the mesoporous support and its catalytic performance towards methanol oxidation improved when compared with commercial carbon (Vulcan XC-72).

Keywords: Ordered mesoporous carbon; Electrocatalyst; DMFC; CO oxidation; Electrochemical characterization

1. Introduction

It is expected that the traditional systems for energy generation would be replaced by fuel cells in a medium long term. The most developed fuel cells are polymeric electrolyte fuel cells, PEMFC and DMFC, the latter using methanol directly as combustible. However, there are several aspects concerning its components that need to be improved. For this objective, the synthetic carbonaceous materials with controllable surface and functional properties can supply innovative solutions. Nowadays, the most commonly used electrocatalyst, both in cathode and anode, is platinum supported on carbon blacks [1–6]. However, it is necessary to obtain a more effective catalyst, both in catalytic performance and electric conductivity. To achieve a higher efficiency of the electrocatalysts, platinum has to be well dispersed on the support. For this reason, it is desirable that the support material provides a suitable specific area and surface chemistry as well as a good electrical conductivity.

Recently, novel non-conventional carbon materials have attracted much interest as electrocatalyst support because of their good electrical and mechanical properties. The examples are supports produced from carbon nanofibers [7–10], carbon nanotubes [11–13], carbon aerogels [14–17] or ordered mesoporous carbons (OMC) [18–21]. The electrocatalysts supported on these non-conventional carbon materials have a better performance in methanol electrooxidation than commercial ones. The ordered mesoporous carbons have received great attention because of their potential use as catalytic supports in fuel cell electrodes since the discovery of the mesoporous silica materials. They have controllable pore sizes, high surface areas and large pore volumes [22–24]. However, they contain a small amount of oxygen surface groups, which is disadvantageous for many applications. The relevance of the functionalization of carbon supports on the dispersion and anchoring of platinum particles on the support has been reported in the literature [25–28]. However, the functionalization of OMC has not been studied in a large extent because their ordered structure could collapse during the process. Ryoo et al. [29] reported in a previous study that ordered mesoporous carbons can maintain an ordered structure even in boiling 5 M aqueous solution of NaOH, KOH, or H_2SO_4 over a week, showing strong resistance to attack by acids and bases. However, Lu et al. modified the surface chemistry of

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