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Highly dispersed and CO_{ad}-tolerant Pt_{shell}-Pd_{core} catalyst for ethanol oxidation reaction: Catalytic activity and long-term durability

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ABSTRACT

Highly dispersed Pt_{shell}-Pd_{core} catalyst is synthesized via an electroless deposition and a galvanic displacement. From electrochemical analysis, the catalyst is confirmed to be active toward an ethanol oxidation reaction for a prolonged time, and is more resistive against CO_{ad}-poisoning than a conventional Pt/C catalyst. The stable activity of Pt_{shell}-Pd_{core}/C is ascribed to the modified electronic property of Pt over-layer, which leads to a weak CO-adsorption strength with a high affinity for OH. The weakened binding property of surface Pt with CO_{ad} was experimentally confirmed by conducting a CO_{ad}-stripping and by measuring an electrochemically active surface area of the catalyst over multiple cycles. The CO_{ad} oxidation ability of as-synthesized catalyst is further proved by a computational method via density functional theory (DFT) calculation. The result presents a potential application of the catalyst for the efficient ethanol oxidation in a direct ethanol fuel cell.

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Introduction

Much attention has been made to proton exchange membrane fuel cells (PEMFCs) due to its versatility as a power source for portable electronics and electric vehicles [1–5]. PEMFCs are classified into H_2-PEMFC (gaseous hydrogen) and direct alcohol-PEMFC (methanol, ethanol), based on which type of fuel is oxidized to generate electrons. Of those, direct alcohol-PEMFC is more advantageous than H_2-PEMFC, in terms of easy storage, transportation, and high volumetric-/gravimetric energy density [6–8].

For the last two decades, direct methanol fuel cell (DMFC), one of the direct alcohol-PEMFCs, has been widely investigated as a future power source. However, methanol is toxic as well as volatile, and therefore it is not an ultimate replacement for H_2. As an alternative fuel, ethanol provides more advantages; safer, more energy density compared to methanol (8.01 kWh kg^{-1} *vs.* 6.09 kWh kg^{-1}) [9,10]. Therefore,

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