MXene-supported platinum catalyst for effective methanol electrooxidation

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In recent years, direct methanol fuel cells (DMFC) as renewable energy sources are increasingly considered one of the most environmentally friendly and promising alternatives for meeting growing energy needs. Although some DMFC technologies are already commercially available there are still several challenges that need to be improved for successful commercialization of DMFC. The biggest challenges are how to overcome the high cost of Pt-based catalysts used in fuel cell reactions, the high catalyst loading required for methanol anodic oxidation reaction, poisoning of Pt catalysts with CO interemdiers during methanol electro-oxidation, methanol crossover issues, and most significantly long-term catalyst durability. One of the main reasons for agglomeration and detachment of platinum nanoparticles from the catalyst support is degradation of the support due to poor oxidation stability, i.e. non-resistance to electrochemical degradation in extremely difficult conditions in the working environment of fuel cells. Recent studies have shown that MXenes can be stable and promising support for Pt nanoparticles with improved reaction kinetics for methanol electro-oxidation reaction. MXenes, a rapidly developing family of two-dimensional layered materials, has shown great potential for use in energy conversion and storage technologies due to its high specific surface area, good resistance to electrochemical corrosion, strong interaction with metal support and also enhanced electrical conductivity. For this reason, MXenes may find use as a catalyst support material for anode processes in fuel cells. This is mainly contributed by the composition of MXenes since they have various functional groups and metal nitride or metal carbonitride materials. The chemical formula of MXenes is $M_{n+1}X_nT_n$, where M represents transition metals, X represents C/N and T represents chemical functional groups such as –OH, -O, and –F groups on the MXene surface.

In this research, platinum nanoparticles deposited on MXenes were synthesized by the microwave-assisted polyol method. The electrochemical behavior of the synthesized catalyst was investigated by cyclic voltammetry, the electro-oxidation of adsorbed CO, and hronoamperometric method. The physicochemical properties of prepared catalysts were characterized by X-ray diffraction (XRD) and X-ray photoelectron spectroscopy (XPS). The high catalytic activity of the Pt/MX catalyst was achieved thanks to the well-balanced conditions of the microwave synthesis, as well as the choice of MXene as the catalyst support.

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