

China's surface modification of metallic bipolar plates of PEMFC: from basic materials to the application technology development

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The proton exchange membrane fuel cells (PEMFC) can be considered as an ideal power source for stationary cogeneration systems and for fuel cell vehicles (FCV). The bipolar plate is the most important component and major part in PEMFC stack manufacturing, and it contribute 60%-80% of the total components of PEMFC stack. The bipolar plates are typically made from conductive metallic, carbon and polymeric materials. The measurements obtained for electrical conductivity ($>100 \text{ Scm}^{-1}$), impact strength ($>40.5 \text{ Jm}^{-1}$), thermal conductivity ($>10 \text{ Wm}^{-1} \text{ K}^{-1}$), interfacial contact resistance ($<10 \text{ m}\Omega \text{ cm}^2$) and current densities for corrosion resistance ($<1 \mu\text{A cm}^{-2}$) are based on DOE targets. Although graphite has excellent chemical stability and good electrical conductivity, but the high processing cost of graphite bipolar plates inhibits its use for PEMFC. Metallic materials, such as stainless steel (SS) with surface coated have

been used in fabricating bipolar plates for PEMFC to achieve specifications that are low cost, safer and highly stable. This work will introduce the research and application of the surface modification technology of the metal bipolar plate for PEMFC in China. Continuous Supported by the National High-tech R&D Program (863 Program) of China, a series of modified films on commercial SS316L plates with different chemical compositions and structures, such as NiCr, CrN, CrC single layer, and NiCr/(NiCr)N, Cr/CrNx/Cr multilayer, were carried out. The research result showed that, coating of SS bipolar plates can improve the corrosion resistance of metallic bipolar plates. Excellent performance of bipolar plates was recorded by using Cr0.23C0.77 coating for SS materials. The ICR value was $2.8 \text{ m}\Omega \text{ cm}^2$ with a low current density (I_{corr}) $0.091 \mu\text{A cm}^{-2}$. And the Cr0.50N0.50 coating also shows well performance with ICR value $5.8 \text{ m}\Omega \text{ cm}^2$ and I_{corr} value $0.59 \mu\text{A cm}^{-2}$. The criteria for both current densities ($<1 \mu\text{A cm}^{-2}$) and electrical conductivity ($<10 \text{ m}\Omega \text{ cm}^2$) met the DOE's 2020 technical targets. The PEMFC stack assembled with this Cr0.23C0.77 coated SS bipolar plate was successfully applied to the fuel cell vehicles and used as the designated VIP car in 2010 Shanghai World Expo.

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