The historical development and current status of gas diffusion electrodes for polymer electrolyte fuel cells (PEFCs) are presented. Two and three-layer electrodes are compared. The effects of both the characteristics and the amount of the materials composing the electrode on the cell performance are presented. These include: the characteristics of the porous substrate; the wettability of the diffusion layer; the characteristics of the catalyst, which is commonly platinum supported on carbon (Pt loading, Pt particle size, Pt/C ratio, Pt depositing method); the presence of perfluorosulfonic ionomer; and the way that the catalytic layer is filled. Attention is also given to the fabrication process of the electrodes and thermal treatments.

Introduction

Interest in polymer electrolyte fuel cells (PEFCs) has considerably increased in recent years largely because their properties are particularly suitable for transportation applications such as space and electric vehicles. Compared with other fuel cell systems they have the advantages of high power densities at relatively low operating temperatures (about 80°C) plus they are small and lightweight. A PEFC consists of a proton conducting membrane (e.g., such as Nafion, the DuPont sulfonated fluoropolymer, which is the most widely used material for proton-exchange membranes) sandwiched between two porous electrodes. The stability of this type of perfluorinated sulfonic acid membrane greatly enhances the lifetime of PEFCs far in excess of alkaline fuel cells (AFCs) — 57,000 h [1] compared with 10,000 h [2].

But because of the well-established record of the AFC power plants in NASA’s space flights, which are only of short duration (less than 2 weeks), there has been little incentive for replacing AFCs with PEFCs. However, for NASA’s proposed long-range space missions — lunar, Mars, and the space station

![Flow chart for the fabrication of (a) two-layer and (b) three-layer electrodes for polymer electrolyte fuel cells (PEFCs).](image-url)