Supporting PtRu catalysts on various types of carbon nanomaterials for fuel cell applications

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Abstract: PtRu catalysts were supported on five types of carbon nanomaterials of various shapes, sizes, and graphitic properties and the catalyst supports evaluated. The carbon nanomaterial used included three types of nanoparticles: Arc Black (AcB), Vulcan XC-72 (Vulcan) and graphene oxide (GO), and two types of nanofibers: carbon nanocoil (CNC) and carbon nanotube (CNT). Pt and Ru were supported by the reduction method using sodium borohydride. The metal catalyst loading was confirmed by thermo-gravimetric analysis (TGA), electron microscopy, and X-ray diffraction (XRD). Transmission electron microscopy (TEM) and XRD revealed that the diameter of PtRu catalyst nanoparticles loaded on reduced GO (rGO) and AcB were ~2 nm and was the smallest among all the samples. Shifts in Pt (111) XRD peaks of CNC and CNT were larger than those of AcB, Vulcan, and rGO. These results suggest that the diameters of catalyst nanoparticles became smaller by loading on the carbon nanoparticles with a large surface area including rGO, AcB, and Vulcan. Loading onto the carbon nanofibers enhanced the degree of PtRu alloying.

1. Introduction

Direct methanol fuel cells (DMFC) are applicable to portable electric power supply because the liquid fuel has a high energy density and DMFC is operated in a low temperature range (room temperature–100°C) [1]. In order to apply DMFCs to commercial electronic devices, low cost, miniaturization, and high efficiency issues needs to be solved [2-7]. As fuel cells employ precious metals including platinum (Pt) and ruthenium (Ru) for the oxidation of fuel and reduction of oxygen, these catalyst metals are required to be used effectively. This can be achieved by using their nanoparticulate form. Carbon nanomaterial is efficient for supporting nanometer-sized metal catalysts and has been used as a catalyst support in energy