Enhancement of characteristics of nitrogen-doped graphene composite materials prepared by ball milling of graphite with melamine: effect of milling speed and material ratios

ABSTRACT

Nitrogen-doped graphene has been prepared using the ball milling method that is known to be eco-friendly, scalable and economic. The parameters studied in the synthesis were the mass ratio of starting materials (graphite and melamine) and speed of the ball milling. To determine its structure and properties, the nitrogen-doped graphene was characterized using Field Emission Scanning Electron Microscopy with Energy Dispersive X-Ray (FESEM-EDX), RAMAN Spectroscopy and X-Ray Diffraction (XRD). Based on FESEM-EDX analysis, the doped composite exhibited nitrogen content of\ ~3.5%. The nitrogen-doped graphene was examined as a replacement for platinum catalysts in fuel cells. Different composite catalysts were evaluated using a Rotating Disk Electrode (RDE) to test the Oxidation Reduction Reaction (ORR) performance. Based on ORR performance comparison, the composite with highest performance was then used to fabricate a Membrane Electrode Assembly (MEA). Testing on MEA performance was conducted on a Fuel Cell Station, where Open Circuit Voltage (VOC) of 0.14 V was obtained. The results indicate that the ball milling method may produce an efficient nitrogen-doped graphene MEA electrode from graphite and melamine only. Compared with a platinum counterpart, the new composite material electrode showed soundly high current-potential characteristics and fuel conversion efficiency.

Keyword: Ball milling; Fuel cells; Membrane Electrode Assembly (MEA); Oxidation Reduction Reaction (ORR); Rotating Disk Electrode (RDE)