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Electrochemical Reduction of CO_2 on a Polyaniline/Cu_2O Nanocomposite Based Electrode

Soon Kwan Jeong, Ki Tae Park
Korea Institute of Energy Research
152, Gajeong-ro, Yuseong-gu, Daejeon 305-343, Korea
jeongsk@kier.re.kr; ktpark@kier.re.kr

Andrews Nirmala Grace
VIT University, Centre for Nanotechnology Research
Vellore 632014, Tamil Nadu, India
anirmalagrace@vit.ac.in

Extended Abstract

Anthropogenic CO_2 in the atmosphere is claimed to be the major contributor to the greenhouse effect. The adverse impacts of global warming include rising sea levels, disappearance of some islands, extreme weather, and climate change. Therefore, reducing CO_2 emissions into the atmosphere has become a critical issue. Various technologies have been developed to reduce CO_2 emissions, such as chemical, thermochemical, photochemical, electrochemical, and biochemical methods. Of these technologies, electrochemical reduction is simple and can be performed under ambient conditions, and is of particular interest since it could both mitigate greenhouse gas emission and use CO_2 as a carbon source to produce a variety of fuels such as formic acid and methanol. However, CO_2 is an extremely stable molecule, so the conversion of CO_2 to a useful fuel on the same scale as its current production is beyond our present scientific and technological abilities. In addition, the direct electrochemical reduction of CO_2 needs at least 1~2V of overpotential. The theoretical potential for the electrochemical reduction of CO_2 to formic acid under standard conditions is -0.854V (SCE, sat. KCl). As a result of the high overpotential, a voltage of more than 4V is required to decrease the cathode potential of any common metal electrode to below -1.545V (SCE, sat. KCl) for effective CO_2 reduction. Thus the development of new catalysts is crucial if we are to reduce this overpotential and create an efficient electrochemical process. This study tested the use of polyaniline matrix decorated with Cu_2O nanoparticles as electrode for the electrochemical reduction of CO_2 to valuable fuels. A simple and novel electrochemical process was used for fabrication of the working electrode. For CO2 electroreduction H-type reactor was designed, and fabricated with Nafion membrane as a separator. The catalyst consisted of Cu_2O nanoparticles deposited onto a polyaniline matrix with an electrochemical method; our results demonstrated the presence of Cu(II) species on the electrode surface. The developed catalyst was tested in the electrochemical reduction of CO_2 by electrolysis at various potentials. The faradaic efficiency tor the formation of formic acid was 30.4% at a polarization potential of -0.3V vs. SCE(sat. KCl). This study offered a simple and effective way for electrochemical reduction of CO_2 to formic acid with an appreciable faradaic efficiency. The synthesis of formic acid from readily available inexpensive raw materials via the electrochemical reduction of CO_2 is expected to be useful in fuel production.