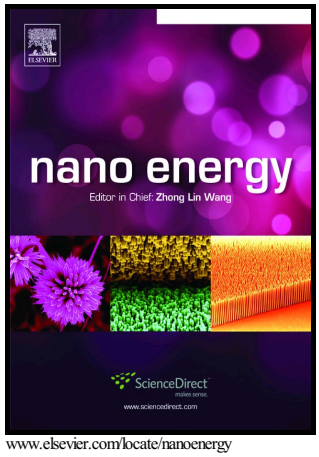

www.elsevier.com/locate/nanoenergy

Enhancing the Rate of Electrochemical Nitrogen Reduction Reaction for Ammonia Synthesis under Ambient Conditions Using Hollow Gold Nanocages

Mohammadreza Nazemi, Sajanlal R. Panikkanvalappil, Mostafa A. El-Sayed

PII: S2211-2855(18)30268-4
DOI: https://doi.org/10.1016/j.nanoen.2018.04.039
Reference: NANOEN2669

To appear in: *Nano Energy*

Received date: 24 March 2018
Revised date: 14 April 2018
Accepted date: 14 April 2018

Cite this article as: Mohammadreza Nazemi, Sajanlal R. Panikkanvalappil and Mostafa A. El-Sayed, Enhancing the Rate of Electrochemical Nitrogen Reduction Reaction for Ammonia Synthesis under Ambient Conditions Using Hollow Gold Nanocages, *Nano Energy,* https://doi.org/10.1016/j.nanoen.2018.04.039

Enhancing the Rate of Electrochemical Nitrogen Reduction Reaction for Ammonia Synthesis under Ambient Conditions Using Hollow Gold Nanocages

Mohammadreza Nazemi, Sajanlal R. Panikkanvalappil, and Mostafa A. El-Sayed*
Laser Dynamics Laboratory, School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, Georgia 30332-0400, United States
melsayed@gatech.edu

Abstract

Ammonia production is imperative to increase the food supply for the growing global population. Ammonia is also considered a major hydrogen energy carrier. The current industrial method for ammonia production is energy intensive and heavily relies on fossil fuels, which are responsible for environmental pollution. To meet ammonia demands, it is necessary to develop sustainable and environmentally friendly production methods that consume significantly less energy than the current methods. The use of nanocatalysis in an electrochemical system under ambient conditions can make an alternative route for fertilizer production. Here, the use of hollow gold nanocages (AuHNCs) as an effective electrocatalyst is evaluated for electrochemical nitrogen reduction reaction (NRR) under ambient conditions. The electrochemical experiments are carried out at various potentials in 0.5M $LiClO_4$ aqueous solution using AuHNCs, and their catalytic efficiency is determined for the conversion of nitrogen to ammonia. The highest ammonia Faradaic efficiency (30.2%) is achieved at −0.4V vs. RHE while the highest ammonia yield (3.9 μg cm^{-2} h^{-1}) is obtained at −0.5V vs. RHE. These are greater than the highest values currently reported in the literature in aqueous solution under ambient conditions. Furthermore, the role of temperature on the electrochemical NRR performance is evaluated. It is found that by increasing the operating temperature from 20°C to 50°C at −0.4V vs. RHE, the ammonia Faradaic efficiency increases from 30.2% at 20°C to 40.5% at 50°C. The electrocatalytic activity of NRR using AuHNCs is further compared with that of solid Au nanoparticles of various shapes (i.e., rods, spheres or cubes) to elucidate the enhanced rate of the reaction resulting from the increase in surface area