Reduction of Carbon Dioxide using a Novel Electrochemical Method with Antimony and Lithium Doped Tin Dioxide Nanoparticles

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In this current study, electrochemical reduction of carbon dioxide to formic acid was carried out by cyclical voltammetry utilizing novel Indium Tin Oxide (ITO) electrode coated with doped (and undoped) SnO2 nanoparticles. A novel sol-gel precipitation method was developed for the synthesis of undoped and Lithium or Antimony doped SnO2 nanoparticles to achieve a particle size in the desired size range of 10-30nm for optimal Faradaic efficiency. Scanning Electron Microscopy (SEM) was used to characterize the microstructure and determine SnO2 nanoparticle size. In order to characterize the crystallinity of the lattice structure, X-Ray Diffraction (XRD) was employed. Nuclear Magnetic Resonance (NMR) spectroscopy was used to determine the concentration of formate produced with varying working electrodes. NMR studies show > 30x higher concentration of formate when reaction was catalytically aided by SnO2 nanoparticles. For stand-alone ITO electrodes, a Faradaic efficiency of 11% was obtained, while for ITO with SnO2 nanoparticles and Nafion, a Faradaic efficiency of 79% (a 7X improvement) was achieved. A significant reduction in over-potential of ~0.7V was also demonstrated with ITO and SnO2 nanoparticles. These highly encouraging results open up further the viability of electrochemical reduction of carbon dioxide to formic acid as a way to answer global challenges such as depletion of fossil fuels and reducing greenhouse gases.

Awards Won:

Third Award of $1,000