A Highly Efficient and Economically Profitable Electrocatalytic Conversion of Carbon Dioxide using Nanostructured Electrodes

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An efficient and economically profitable process for the electrochemical conversion of carbon dioxide to valuable chemicals such as methanol and formic acid was investigated to address the steady increase of atmospheric CO2. Undoped, Lithium (p-type) and Antimony (n-type) doped nanoparticles were synthesized over a wide range of particle sizes using a sol-gel precipitation method, to act as electro-catalysts in the reduction process. Scanning Electron Microscopy was used to characterize the morphology and nanoparticle size. The CO2 reduction was carried out by cyclic voltammetry using a home-made three-electrode system based on Indium Tin Oxide (ITO) working electrode coated with SnO2 nanoparticles, Pt counter electrode and Ag/AgCl reference electrode. Nuclear Magnetic Resonance (NMR) was used to determine the concentration of products produced. NMR studies show a 30-fold increase in the conversion of CO2 when p-type SnO2 particles were used. For the stand-alone ITO electrodes (control), a Faradaic efficiency of 0.01% was obtained as compared to an efficiency of 47.4% for ITO with p-type SnO2 nanoparticles to form formic acid. For the reduction to methanol, a control Faradaic efficiency of 5.09% was obtained as compared to an efficiency of 84.4% for p-type SnO2 electrodes. The application of novel p-type SnO2 highlights the originality of this method as a significant improvement in electrochemical efficiency was achieved. The improved reduction efficiency allows for the process to be economically profitable as the energy cost is less than the revenue generated when selling the primary products, formic acid and methanol. These highly encouraging results open up the viability of electrochemical reduction of CO2 as a way to answer global challenges such as global warming.

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