Powering Fuel Cells with CO over Gold Nanotubes and Nanoparticles: The Idea and Its Implications

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Electricity was produced by catalytic oxidation of carbon monoxide (CO) at room temperature using polyoxometalate (POM) compounds over gold catalysts, thereby eliminating the water-gas shift reaction and the need to transport and vaporize liquid water in the production of H_2 for fuel cells. This process can utilize CO-containing gas streams from catalytic reforming of hydrocarbons to produce an aqueous solution of reduced POM that can be used to generate power by re-oxidizing the reduced POM in fuel cells containing simple carbon anodes. This process is especially promising for the production of electrical energy from renewable biomass-derived oxygenated hydrocarbons because these reactants have C:O stoichiometric ratios equal to 1:1, and they therefore generate H_2 and CO in nearly equal amounts during catalytic decomposition. We show the preferential oxidation of CO in H_2 (PROX) process using a reversible POM oxidant, in contrast to the irreversible O_2 oxidant and also demonstrate a novel electrochemical device for production of hydrogen gas or for transfer of hydrogen to benzene from the aqueous solutions of POMs that have been reduced by CO over gold nanoparticle catalysts.