MAR06-2005-006483

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Bio-inspired constructs for solar energy conversion

THOMAS MOORE, Arizona State University

Solar energy input to the biosphere is about 10^{24} joules/year. This makes human needs of even a projected 10^{21} joules/year a deceptively achievable goal. One key to global-scale use of solar energy is the synthesis of energy-rich fuel materials such as hydrogen and reduced carbon compounds. The latter have the almost inestimable advantage that the energy infrastructure for distribution and use is in place. The photosynthetic and respiratory enzymes provide paradigms for all of the important energy converting processes humans would need to achieve sustainable energy production and use. These include water oxidation, O_2 reduction and oxidation of energy dense organics at room temperature. These processes are carried out by biological catalysts at near thermodynamic efficiency without the use of precious metals. Copper, manganese, iron and nickel are typically used at their active sites. Energy rich organics such as ethanol and larger reduced-carbon compounds offer energy densities comparable to that of fossil fuels yet technology has not produced a low temperature catalyst for breaking carbon-carbon bonds. Biology offers myriad examples of such catalysts. Electroreductive synthesis of organics from CO_2 is also templated by Nature's catalysts. The challenge is clear: we must understand the structures and chemical reactivity of these catalytic sites and co-opt their essential features for human use. A number of parameters are involved and will be discussed. Even considering an artificial catalysts comprising only the atoms necessary for catalysis, the footprint is relatively large and, since biological turnover rates are often low, achieving current flows adequate for human needs in industry and transportation is problematic. A detailed understanding of efficiently coupling electromotive force to the active sites of redox enzymes will be one key to designing efficient hybrid catalytic devices. A model system for solar-driven reforming of biomass to H_2 will be presented.