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Electrochemical assessment on the corrosion of carbon steel in simulated fuel-grade ethanol and the inhibitory effect by PEG-40 hydrogenated castor oil

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The electrochemical behavior of carbon steel in simulated fuel grade ethanol (SFGE) and the effect of water and chloride ion have been studied by using cyclic voltammetry and potentiodynamic polarization techniques and complemented by scan electron microscope (SEM) investigations. The presence of water and chloride ion in SFGE strongly influences the electrochemical behavior of carbon steel. The increase in water and chloride ion concentrations induces pitting and general corrosion. Polarization curves indicate that PEG-40 HCO has good inhibition efficiency and behaves as mixed inhibitor. The adsorption of PEG-40 HCO obeys Langmuir adsorption isotherm.

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Structure-property relations in functionalized materials for efficient electrocatalysis and electrochemical energy conversion

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There has been growing interest in the electrochemical reduction of largely inert carbon dioxide. To optimize the hydrogenation-type electrocatalytic approach, we have proposed to utilize nanostructured metallic centers (e.g. Pd, Pt or Ru) in a form of highly dispersed and reactive nanoparticles generated within supramolecular network of distinct nitrogen, sulfur or oxygen-coordination complexes. Among important issues are the competition between hydrogen evolution and carbon dioxide reduction and the specific interactions between coordinating centers and metallic sites. We have also explored the ability of biofilms to form supports of hydrogel-type aggregates of microorganisms attached to various surfaces including those of carbon electrode materials. Another possibility to enhance electro-reduction of carbon dioxide is to explore direct transformation of solar energy to chemical energy using transition metal oxide semiconductor materials. Here we showed that by intentional and controlled combination of metal oxide semiconductors (titanium (IV) oxide and copper (I) oxide), we have been able to drive effectively photoelectrochemical reduction of carbon dioxide mostly to methanol. Application of mixed-metal oxides as active matrices is also of particular importance to electrocatalytic oxidations of small organic molecules (fuels). For example, during oxidation of ethanol (e.g. at PtRu), when rhodium nanoparticles have been dispersed in between WO₃ and ZrO₂ layers, significant current enhancements are observed. The result can be rationalized in terms of the hydrous behavior of oxide matrices favoring proton mobility as well as the formation of nano-reactors in which Rh induces splitting of C-C bonds in C₂H₅OH molecules before the actual electro-oxidation steps. We also consider nano-electrocatalytic systems permitting effective operation of the iodine-based charge relays in dye sensitized solar cells. The ability of palladium or platinum nanostructures to induce splitting of I-I bonds in the iodine (triiodide) molecules is explored here to enhance electron transfers in the triiodide/iodide-containing 1,3-dialkylimidazolium room-temperature ionic liquids.

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