Electrocatalysis of gas hydrates at subfreezing conditions

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So far electrocatalytic process in aqueous solution have been extensively studied as a function of the temperature in the range 0 and 99 °C but very little is known about electrocatalytic processes at temperatures below the freezing point. In electrochemistry at low temperatures, the reactions associated with water splitting might be suppressed due to the formation of ice-like structure at the interface, while the stabilization of other reaction species can be stabilized resulting in changes to the kinetics of the reactions studied.[1-3] In addition, decreasing the temperature of water to subfreezing temperatures would significantly increase the solubility of some gases in water thus affecting the reaction rate of the electrochemical reactions.

Gas hydrates or clathrates are a crystalline solid formed of water and gas. Clathrates looks and acts much like ice, but it contains large amounts of gas trapped within a crystal structure of water. Gas hydrates such as hydrates of hydrocarbons, sulfur dioxide (SO_2) and carbon dioxide (CO_2) have been reported but they are only used for academic purposes with just a very few examples which have reached technical application. However, gas hydrates might have play an important role in the origin of life, and the chemistry on gas hydrates is relevant in energy and environmental applications.

We will show the electrochemical behavior of hydrogen and oxygen adsorption and desorption processes on different metal electrodes in aqueous brines at subfreezing temperatures. Finally, we will report the first electrochemical results of the carbon dioxide reduction reaction and the oxidation of methane in aqueous brines at subfreezing temperatures down to -40°C. Our results will be explained on the basis of the presence of ice-structure clathrates,[4, 5] concentrations and the changes in the pH of the solution[6, 7].

References

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