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NEW HYPOTHESES FOR HYDROGENASE IMPLICATION IN THE CORROSION OF MILD STEEL

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ABSTRACT

Losses due to corrosion are evaluated at 4% of the GDP of industrialised countries and biocorrosion may be responsible for 10% of these costs [1]. Whereas the general mechanism of anaerobic corrosion, involving iron sulphur deposits, seems now well agreed, the detailed mechanism is still unclear and the implication of hydrogenase is very controversial. The influence of a [Fe] hydrogenase from C. acetobutylicum on mild steel corrosion was studied using a galvanic cell with two electrodes and measuring the galvanic current and the free potential. The galvanic cell was composed of two compartments separated by a dialysis membrane (spectra pore 12-14 kDa). Two electrodes made of XC45 mild steel 2cm diameter were put face to face in the galvanic cell and coupled through a Multimeter. The dialysis membrane held the enzyme on the surface of only one electrode while both electrodes were exposed to the same solution. Oxygen was removed by continuous nitrogen flow. In the galvanic cell, the presence of hydrogenase on the surface of only one electrode induced a galvanic current up to 10µA and the potential decreased by 500mV in the presence of phosphate. This phenomenon stopped after a couple of hours because of the formation of a vivianite deposit. The vivianite deposit which forms a protective barrier to corrosion [2], was identified by MEB and EDX analysis. Depending on whether the enzyme is activated, deactivated or denaturized, the galvanic current could reach negative values up to -18µA or positive values up to +13µA and therefore the electrode exposed to the enzyme could act either as anode or cathode. The electrode exposed to active hydrogenase showed heterogeneous corrosion. The mechanism is discussed as a function of the enzyme state, focusing on the possible involvement of FeS clusters. It seems that this [Fe] hydrogenase has similar mechanism than the [Ni-Fe] hydrogenase that has been previously studied [3, 4].


Keywords : Hydrogenase, corrosion, mild steel, FeS clusters.