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► **To cite this version:**

Anthony Diderot, Julien Jaume, Maria João Marques, Marie-Line Délia, Régine Basséguy. How microorganisms can help to protect 5083 aluminium alloy from corrosion in marine environment. 34th Topical Meeting of the International Society of Electrochemistry, Mar 2023, Mar Del Plata, Argentina. <hal-04753682>

HAL Id: hal-04753682

<https://hal.science/hal-04753682v1>

Submitted on 25 Oct 2024

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How microorganisms can help to protect 5083 aluminium alloy from corrosion in marine environment.

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In marine environment, biocorrosion has been widely studied on stainless steel: the main assumption is that biofilm catalyses the reduction of dioxygen which results in an increase of the Open Circuit Potential (OCP) [1]. Very few studies deal with biocorrosion of aluminium alloys in marine environment. On the one hand, recent works showed that a protective layer developed on the surface of the material under the influence of marine microorganisms [2]. On the other hand, Watkins and Davie previously worked on the effect of cathodic polarization on the corrosion of alloy 6351 (Al-Mg-Si) in sterilized (abiotic) seawater [3]. They showed the formation of an oxide layer, rich in magnesium and calcium, whose composition and efficiency in terms of protection depended on the applied potential and on the pH in the vicinity of the interface. In this context, it is then relevant to think that microorganisms, like cathodic polarization, allow the formation of a protective layer facilitating the reduction of dioxygen, which leads to the increase of the pH. The work presented here aims at validating this hypothesis.

The tests were carried out in electrochemical reactors containing seawater and salt marsh sediments as source of microorganisms.

Firstly, 5083 aluminium alloy (Al-Mg) electrodes were immersed for 10 days in biotic and abiotic environments (abiotic = autoclaved salt marshes) and OCP was recorded. Mass gain measurements showed a greater amount of protective deposit formed when microorganisms were present. Linear sweep voltammeteries were performed on some of these electrodes. The polarization curves (drawn from 0 to -0,7V/OCP) highlighted the catalytic effect of the microbial activity on the reduction of dioxygen for potentials between -0.8 and -1.0V/SCE (Fig 1a).

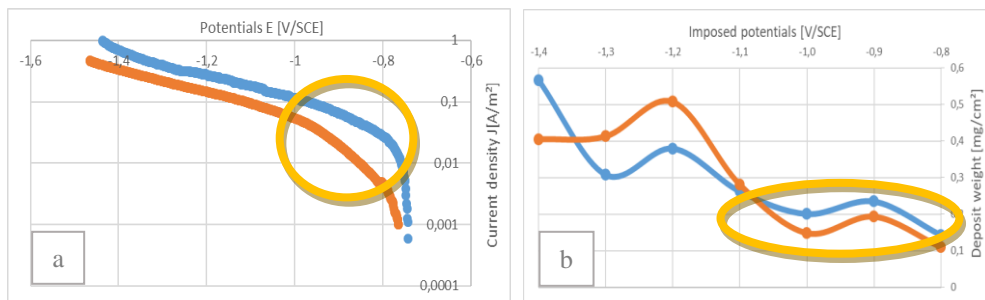


Figure 1: a) Polarization curves obtained with Al-Mg 5083 electrodes in biotic medium (seawater + active salt marshes) in blue and in abiotic medium (seawater + autoclaved salt marshes) in red. b) Evolution of the mass of the protective deposit depending on the cathodic potential applied in biotic environment in blue and abiotic environment in red.

Secondly, according to the experiments performed by Watkins and Davie, 5083 aluminium alloy electrodes were polarized at potentials between -0.8 and -1.4 V/SCE in biotic and abiotic marine environments for 10 days. The mass (mg/cm^2) of protective deposit was determined. Higher values were obtained in presence of microorganisms for potentials between -0.8 and -1.0 V/SCE (Fig. 1b). These results fit with the potential range where the biocatalysis of dioxygen reduction occurred.

In conclusion, the dioxygen reduction reaction and the presence of microorganisms are two important parameters for the formation of the protective layer. Microbial activity, by modifying the reaction kinetics and by facilitating the electronic exchanges, as cathodic polarisation does, promotes the formation of a larger amount of protective deposit.

This work was financially supported by the french ANR, MICOATEC project (ANR-19-CE08-0018).

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