

2. APPLIED CHEMISTRY

CORROSION AT THE INTERFACE BETWEEN CHEMISTRY AND BIOLOGY: MIC AND MAC

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Corrosion is the physicochemical deterioration of materials, typically metals, resulting from interactions with their environment. It involves electrochemical or chemical reactions that lead to the gradual loss of structural integrity, often manifesting as surface degradation, pitting, or material failure. Its impact on the economy of a nation is enormous: it is being estimated at 3.8% of the gross domestic product of that nation (or the added value of a company), a value that increases to 19.9% in the case of a maritime company or a port.

Observing corrosion in real life, especially in a marine context, is exacerbated because of the added biotic factors, both on a microscopic and a macroscopic level. Microbiologically influenced corrosion (MIC) drives material degradation by direct electron uptake or through the metabolic activity of microorganisms (such as production of acids or redox-active molecules), leading to localized corrosion phenomena such as pitting, tuberculation, and accelerated material loss. MIC is particularly relevant wherever environmental factors and microbial ecology shape corrosion dynamics and mitigation strategies.

Macrobiota (called macrofouling in the maritime context) affect corrosion of steel surfaces by creating a local microclimate with crevices, by offering a niche for bacteria to settle and create biofilms, or by secreting metabolites which interact with the steel. On the other hand, the creation of calcified layers on the steel by barnacles, mussels and oysters may mitigate corrosion processes, slowing down the degradation of the surface and potentially protecting the structures. This interplay leads to a complex process which can be named “macrofouling-affected corrosion” (MAC).

When investigating a specific case in which micro- or macrofouling may play a role, it is therefore important to take this complexity into account. The assessment of MIC (and probably also MAC) requires a *multiple lines of evidence* (MLoE) approach, involving material science, microbiology and molecular biology, an analysis of the structures formed on and in the steel, and even design aspects of the installation involved.