MARINE BIOMINERALIZATION FOR ENHANCED CORROSION RESISTANCE: INSIGHTS FROM THE ANR MICOATEC PROJECT

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Concerns about marine pollution and ecological threats caused by traditional corrosion protection technologies have driven the development of new environmentally friendly anti-corrosion solutions. In recent years, it became clear that microorganisms have the potential to positively impact corrosion behavior, a phenomenon known as MICI (microbiologically influenced corrosion inhibition) [1,2]. Although research on MICI mechanisms is still in the beginning, two main mechanisms have been outlined: direct and indirect inhibition. In the first one, the microorganisms are responsible for the segregation of slow-release inhibitors or surfactants or consume oxygen, which affects the cathodic reaction process. The second one, indirect inhibition mechanism, is associated to the formation of a protective layer on the surface of the material due to metabolic activity of microorganisms. In this context, biomineralization attracted the attention of researchers as a solution to inhibit metal corrosion.

Being aware of the potential of this microbial induced mineralization phenomenon, the French ANR MICOATEC project (www.micoatec.eu) established a new approach for the development of a bioinspired anticorrosion solution for metal protection based on the biomineralization process observed on an Al-Mg surface during exposure in marine field. The main goal is to translate the natural biotic process into an abiotic technological process for corrosion protection, without replicating the biofilm itself or incorporating active biocompounds into a coating matrix (figure). Three specific objectives were outlined:

(1) Understanding the interactions of aluminium alloys with marine biological activity which leads to the formation of a layer that can inhibit corrosion (protective layer).

(2) Mastering the growth process and the physico-chemical properties of the protective layer on the alloy surface under the influence of biological activity, and

(3) In the longer term, providing the industry with a bioinspired technology for anticorrosion coatings that is more environmentally friendly in order to increase the lifespan of metal structures.

The work of the multidisciplinary consortium has led to numerous results in research activities associated with the growth process (WP1) and anti-corrosion properties (WP2) of the protective layer, providing the bases for replication steps (WP3). Among the most important results, we can cite:

(i) The Al-Mg surface modifications showed to be strongly influenced by the type of fouling present, notably photosynthetic, such as algae.

(ii) The anticorrosion properties of the formed layers are intimately linked to their structure and chemical composition.

(iii) Replication in a biotic environment (seawater + salt marshes) is currently being mastered.

MICOATEC has allowed to confirm marine biomineralization as a potential new approach for the development of anti-corrosion solutions inspired from biological interactions with metals.

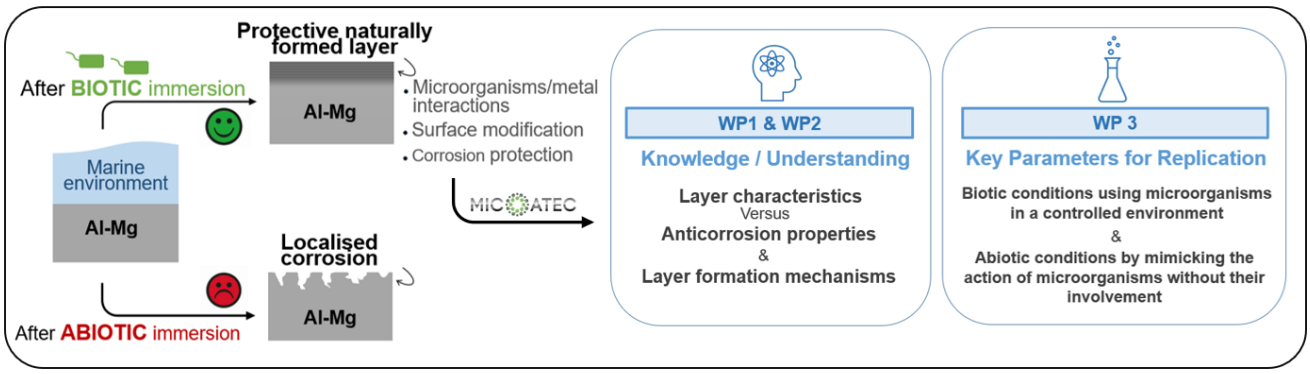

Figure - MICOATEC project: New concept of Microbially Inspired anticorrosion coating technology. Work Packages (WP)

Keywords: Aluminium alloy; Marine Corrosion inhibition; Biomineralization; Bioinspired protection solution

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