Microbial action as an inspiring tool to propose innovative corrosion protection processes

R Basséguy[a], MJF Marques[a,b]

a. Laboratoire de Génie Chimique, Université de Toulouse, CNRS, INPT, UPS, Toulouse, France
b. LMR – Laboratório de Materiais e Revestimentos, LNEG – Laboratório Nacional de Energia e Geologia, Lisboa/Portugal

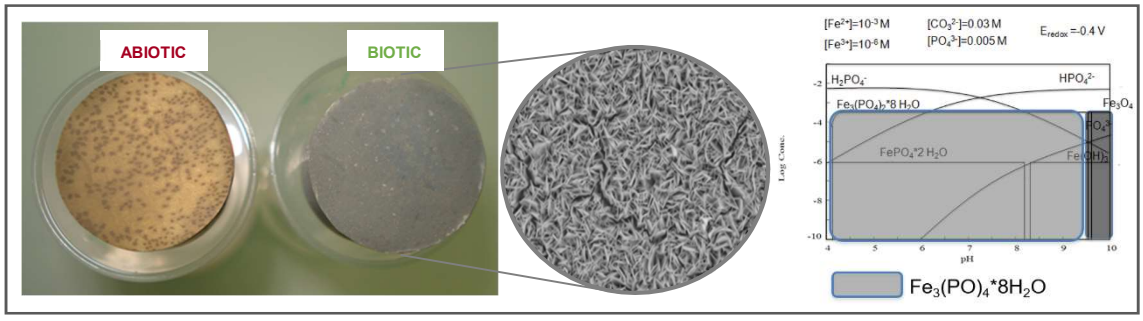
Among the strategies employed to protect metallic materials, coatings can be considered as one of the most successful and cost-effective alternatives to increase the service lifetime of metallic structures, particularly in industries that are continuously exposed to changing and hard weather conditions such as shipbuilding, automobile, aerospace, marine and oil & gas energy infrastructures. However, towards a more constraining legislation as REACH, the surface treatment & coating Industry is at the forefront in developing innovative and even more sustainable products.

In the last decades, new emerging microbial-based technologies, including biomineralisation, have been proposed to protect metallic materials. They are based on the recognition that microorganisms do not only accelerate corrosion (MIC), but can also inhibit or protect against corrosion (MICI). The objective of this presentation is to show, through 2 case studies, how the biogenic mineral precipitation on materials can be regarded as a solution to protect surface against corrosion.

The first case study presents a thermodynamic analysis to explain the formation of vivianite (iron (II) phosphate) on carbon steel in presence of *Geobacter sulfurreducens,* an iron reducing bacteria. In solution containing phosphate species, the high availability of Fe(II) ions, produced by the bacteria that reduce Fe(III), promotes the formation of a vivianite layer. This phosphate layer is believed to be formed by the combination of decreasing the redox potential in the solution and the direct electron transfer between bacteria and corrosion products.

The second case concerns the formation of a natural coating by biomineralization process on Al-Mg alloy surface during its immersion in marine environment. Work carried out at three different scales (field, semi-field and laboratory) concludes that marine microbial activity has a significant effect on the evolution of the Al-Mg surface from the early stages of exposure. In the MICOATEC French project, the natural protection phenomena developed during the interaction process between living organisms and the metal surface is envisaged as a novel vision to develop anticorrosion solutions.

Case 1: Carbon steel



Case 2: Aluminium-Magnesium alloy (AA 5083)