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Microbial extracellular polymeric substances -EPS- mediate biocorrosion/bioleaching?

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Abstract:

Biocorrosion or Microbially Influenced Corrosion involves per definitionem the action of living organisms, mostly microorganisms, in the corrosion of working materials. Under microorganisms we summarize highly diverse groups of organisms like bacteria and archeae, protozoa and algae, fungi and lichens. In which way these groups contribute and/or cause corrosion, is known only to a very limited extent. The general understanding assumes that organisms are excreting deleterious compounds, which corrode or degrade working materials (like sulfuric acid or hydrogen sulfide) or that they degrade working materials to use them as a nutrient (mainly organic compounds like polymers etc). The general understanding is that these processes are done by microorganisms to cause problems for us! However, this understanding is far from reality.

Microorganisms use working materials, because they are either "food" for them or provide a "sink" for deleterious metabolic intermediates and/or endproducts. To be able to use the materials, microorganisms have to be in the direct vicinity meaning they have to have physical contact or be at least in a distance, which still allows an electron transfer (between microbial cell and material - as a rule 20 Angström/2nm). Since we have no techniques available to look into such tiny dimensions, we are mostly restricted to use indirect methods for elucidation of the occurring processes. For this reason we focus on the substances, which mediate the contact between microbial cells and the working material, i.e. the Extracellular Polymeric Substances – EPS. We know that practically all microorganisms are surrounded by EPS. These compounds consisting of sugar, sugar acids, lipids, proteins and extracellular DNA produce a reaction space around the cells. This space contains also exoenzymes (oxygen reduction etc.), complexed metals (like Ca, Mg, Fe, Mn etc.) and protons. Thus, by the EPS an own microspace is created, where conditions are quite different from the surrounding "bulk" solution. These special conditions are responsible for the accelerated reactions caused by microbial catalysis.

The EPS are responsible for the mediation of contact between (microbial) cell and working material. Either hydrophilic or hydrophobic surface compounds plus complexed metal ions cause the (first) interactions between materials and cells. These interactions result in the attachment of microorganisms to the surface of materials and consecutive metabolic activity causing subsequently the materials dissolution. Thus, besides creating a special reaction space EPS contribute to biocorrosion via adhesive compounds, exoenzymes and complexed corrosion-causing metal ions.