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Environmentally-friendly, enzymatic anticorrosion and antifouling coating

A method to reduce microbial-caused corrosion and biofouling through the use of an enzymatic coating to disrupt bacterial communication

Technology No. 2020-155a

Bacteria eat literally hundreds of billions of dollars in steel each year

More than $300 Billion is lost from the US economy every year due to metal corrosion. Where metal structures are submerged underwater, bacteria drastically speed up corrosion through the formation of complex microbial communities called biofilms. Multiple approaches have been attempted to combat biocorrosion, including the use of biocidal compounds, which show low efficacy against biofilms and pose an environmental hazard due to their toxicity. Biofilms also lead to biofouling (the adherence of larger macroorganisms) which is detrimental to numerous industries, including transportation, oil industry, aquaculture, air conditioning, etc. Similar to the approaches taken to combat biocorrosion, antifouling approaches are dominated by copper, a toxic metal that harms the environment and is challenged by regulation. Research out of the University of Minnesota has developed an alternative solution to bypass these limitations. A key step in the formation of many biofilms is bacterial communication through molecules known as quorum signals. By incorporating enzymes engineered to break-down quorum signals into steel coatings, researchers were able to reduce biocorrosion by 50%.

Interfering with bacterial communication

Bacterial communication is vital for the formation of biofilms and subsequent biofouling, and interfering with this communication may mitigate against biofilm formation. Bacteria often secrete acyl homoserine lactones (AHLs), a molecule required for quorum sensing and biofilm formation. AHLs are degraded by the enzyme lactonase. University of Minnesota researchers have engineered lactonases in order to maximize enzyme stability and activity against a wide variety of lactones. These improved enzymes are soluble in a variety of solvents (including organic) or coatings and retain activity long-term. Studies with submerged steel surfaces coated with lactonase-containing coating showed a 50% reduction in corrosion tubercles compared to surfactin (31%) and magnesium peroxide (36%) coatings. The robustness of these enzymes and their ability to combat biofilms and biofilm-mediated corrosion or clogging, lends them to a wide variety of industrial applications. These applications include: coatings for boat hulls, underwater structures, plumbing, fish tanks, fracking and oil pipes or as a coating or spray for surfaces to prevent contamination or infection.

To learn more about applications in the biological sciences, read our complementary postings, 20160278b and 20160278c.

Phase of Development

Proof of concept. Experiments have shown that the enzymes can be added to a coating on steel, retain activity and successfully prevent biocorrosion.

Features & Benefits

- **Prevents and disrupts biofilms:** Lactonase breaks down the AHL lactones used for quorum sensing by bacteria, a key step in the formation of biofilms.
- **Non-toxic:** Based on research and animal feeding studies, no environmental or health hazards have been identified, which are commonly associated with biocidal compounds.
- **Robust and useable in diverse environments:** The enzymes are temperature, protease, acid and age resistant, retaining activity even in organic solvents.
- **Conventional production methods:** Enzyme can be readily produced using fermentation.

Applications

- Marine anti-fouling coatings
- Coating or spray for food preparation/medical procedure or device surfaces

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Publications

Evaluation of biological and enzymatic quorum quencher coating additives to reduce biocorrosion of steel
PLOS ONE, May 16, 2019

Ready for Licensing

This technology is now available for license! The university is excited to partner with industry to see this innovation reach its potential. Please contact us to share your business' needs and your licensing interests in this technology. The license is for the sale, manufacture or use of products claimed by the patents.

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