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Low Biocide Emission Antifouling Based on a Novel Route of Barnacle Intoxication

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Abstract

Marine biofouling can be defined as the colonization of man-made surfaces in seawater by microscopic and macroscopic organisms. This phenomenon can result in great loss of function and effectiveness both for cruising ships and for static constructions. Of special concern are the negative effects of hard fouler such as barnacles, which cause increased drag resistance resulting in increases in fuel consumption, and disruption of the corrosion protective layer of marine vessels and constructions. Present biocide-based antifouling strategies are based on a continuous exposure of biocides at the film/water interface and consequently release into the environment if the antifouling efficacy is to be maintained. Such biocide-based solutions can therefore not be regarded as sustainable.

The aim of this thesis is to describe the possibility to design biocide antifouling coatings based on a new strategy. Instead of releasing the bioactive molecule to the bulk water the biocide will be "entrapped" in the paint matrix and only after stimuli by organism interaction with the paint surface intoxication will take place. It was shown (Paper I) that using an experimental formulation, containing ivermectin, both in static panels and on boats, long lasting protection against barnacles was obtained. Moreover, using two model surfaces (Paper II), it was possible to separate and study the different contributions to the antifouling efficacy, finding that the low leaching of ivermectin had no contribution at all while surface's modulus of the coating was the key factor. This supports the validity of the contact active antifouling hypothesis, rather than emission based. In (Paper III) we could follow the fate of barnacle growing on ivermectin containing coatings, and both field and laboratory tests could demonstrate that the intoxication of barnacles start when the juvenile organism reach ca. 0.6-0.7mm in diameter. Electronic microscopy images on the panels after the test, demonstrate that on control paint (no biocide) the juvenile barnacles (0.6-0.7mm diameter) already leaves imprint or penetration marks on the rosin based coatings. The distribution of ivermectin in the dry film seemed to be related with enhancement of barnacles contact intoxication. This was studied by fluorescence microscopy in (Paper I) and by the use ToF-SIMS in (Paper IV). This particular analytic method gives the possibility to follow organic biocides in paint film without the need of labelling or modify the biocide molecule in any extent.

The entrapped antifouling strategy opens up the possibility to achieve long term antifouling (>10 years) as there is no need to use erosive binders. Moreover, this system might also find it uses in marine constructions and other fields where maintenance is difficult.