# COMBATING BIO-FOULING OF SENSORS AND ENVIRONMENTAL PLATFORMS IN THE MARINE ENVIRONMENT

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*Abstract - Biofouling is a ubiquitous natural process whereby organisms such as bacteria, algae or invertebrates form a living biological layer, typically at the interface between a solid surface and an aqueous environment. The build up of biofouling is a process that can impair the function of many artificial mechanical devices across a number of different disciplines, ranging from medicine to engineering and marine transport. This work shows the development of novel materials based on bio-inspired design and novel polymeric coatings for prevention of anti-fouling on sensor housings. Results of tested anti-fouling coatings are presented. The effect of topographic features is shown to impact on the settlement of diatoms in the early stages of biofilm formation. Novel polymeric coatings show promise in prevention of bacterial attachment. The results from the deployment of antifouling materials together with real-time water quality data from the test site is shown.*

**INTRODUCTION**

Real-time continuous monitoring of Dublin Bay has illustrated the potential of sensor systems in management of a marine environment. Data form a YSI Hydrodata sonde collected at 10 min intervals illustrates the impact of ship movement in the port and provides an insight to when samples for biological and chemical parameters should be taken. The main challenge of sensing in the aquatic environment is biofouling of the sensors causing the data quality to degrade and increasing the cost of ownership of a monitoring system. Specifically in the marine environment, biofouling has historically been kept in check by a range of biocides and self polishing paints. The ban of TBT in 2008, has led to the need to research and develop novel alternative non-toxic antifouling strategies. Recent research has shown that physical surface micro-topography (micro-patterning) can significantly influence the rate of and strength of attachment of a marine biofilm by altering surface properties such as free energy and hydrodynamic flow or boundary layer thickness over the surface. The ability to significantly reduce or prevent biofilm formation by surface topography manipulation, inherently non-toxic in nature, would have many applications in marine and sensor technology applications. It appears that manipulation of surface roughness and topography has already been incorporated into antifouling strategies in the marine environment by certain marine organisms and we will present the results of our research into how natural surface topographies are used by crustaceans (Figure 1), molluscs and certain fish species to control biofouling. In tandem with this we are investigating the role that engineered biologically inspired micro-textures with very specific dimensions can play in the attachment rate of particular common marine fouling species and how best microtopography can be employed practically in the marine environment to reduce fouling. In parallel, we report the use of plasticised poly vinylchloride (PVC) as a potential antifouling coating material. The materials contain a variety of sebacic and succinic acid derived plasticisers providing a variation in molecular shape and structure; diethyl succinate (DESn), di-(2-ethylhexyl sebacate) (DEHS), dibutyl sebacate (DBS) and diethyl sebacate (DES). Each plasticiser from the sebacate group possessed the same basic $C_{10}H_{16}O_4$ moiety with varied dialkyl terminated groups affording a different range of homologous series plasticisers. The work investigates if branching of the side substituted alkyl chains on each plasticiser molecule affects microorganism attachment and subsequent fouling. The plasticised polymers are spin coated to create thin films for testing. In order to determine the antifouling capacity of the materials, the polymer coatings underwent a series of analyses for biomass determination, glycocalyx production and protein and carbohydrate adsorption. Topological and morphological characterisation was carried out using scanning electron microscopy (SEM) and atomic force microscopy (AFM). After an environmental study it was found that the plasticisers with increased alkyl branching, DESN and DEHS showed the greatest degree of prevention of microorganism colonisation and attachment thus significantly reducing the initial formation of biofilms by up to 65% in some biofouling assays when compared to the uPVC blank. Results of field trials illustrate the improved performance of the novel anti-fouling materials.

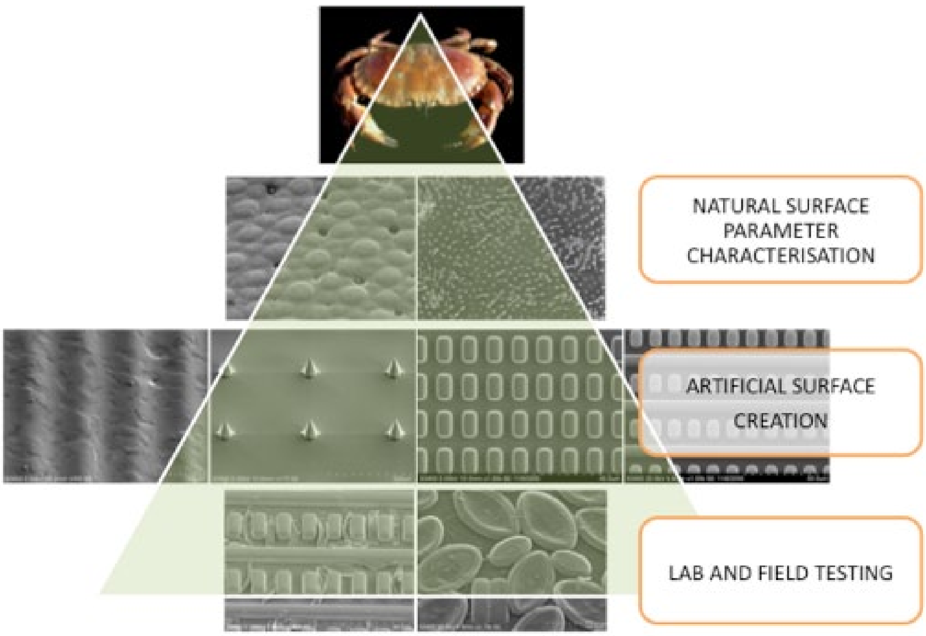


***Figure 1: Strategies for the development of antifouling surfaces based on biomimetic design.***