Development of bio-inspired antifouling coatings

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Introduction

Biofouling is the accumulation of micro and macro organisms on a solid surface exposed to a marine environment. It cause a reduction of operational effectiveness of marine structures[1]. The process begins with the settlement of microorganisms on the surface demonstrated in figure 1, the microorganisms then produce Extracellular Polymeric Substances (EPS) forming a biofilm.

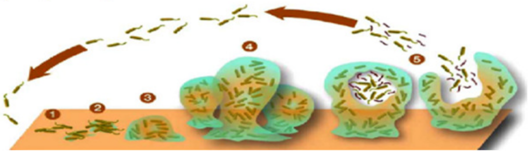

Figure 1: Biofouling process [5]

Hydrophobic surfaces have been shown to inhibit biofouling and it has been noted that some strains of macroalgae use surface topography and leaching of antimicrobials to minimise biofouling [2].

Figure 2 illustrates some of the effects rough surfaces have on biofilm growth. Micro bubbles can get trapped reducing the surface available for adhesion. The angled surface can weaken the adhesion causing microbial lift off and it separates the microorganisms reducing their interaction necessary for EPS production[3].

The cells that do settle are then affected by the antimicrobials leached from the surface and their growth limited. The samples were doped with an extract from *Cystoseria baccata* and a *salacornia* macroalgae extract and set these epoxy samples in a mould of a *Cancer pagurus* carapace surface[4].

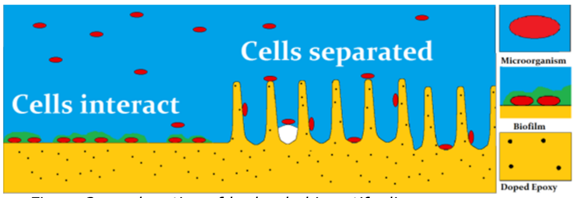

Figure 2: explanation of hydrophobic antifouling

Method

Figure 3 shows the process used to recreate the *Cancer pagurus* carapace shell. Polydimethylsiloxane (PDMS) was cast over a section of *Cancer pagurus* carapace to make a mould. The shell was removed creating a negative mould of its surface.

Epoxy resin was doped with an antimicrobial extract of macroalgae and cast into the PDMS mould.

Clean and undamaged glass was cut into the same surface area as the crab shell and an epoxy mould made to create a flat control sample.

After curing the surfaces were characterised by contact angle (CA), SEM microscopy and its resistance to biofouling is under current analysis.

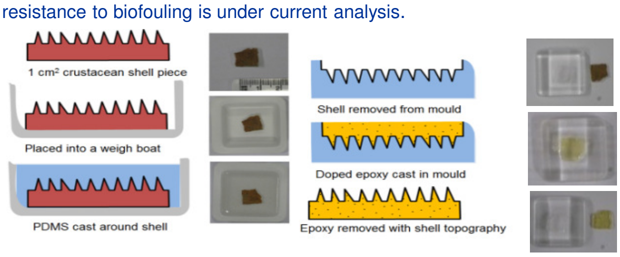

Figure 3: production steps of surface replication in epoxy resin

Results

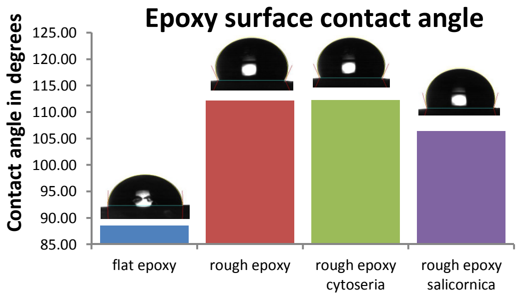

Figure 4: contact angle results

Results in figure 4 show the contact angle of flat epoxy is not hydrophobic and so it will not have an effect on biofouling.

The epoxy with crab shell topography is hydrophobic and is expected to reduce biofouling on the surface.

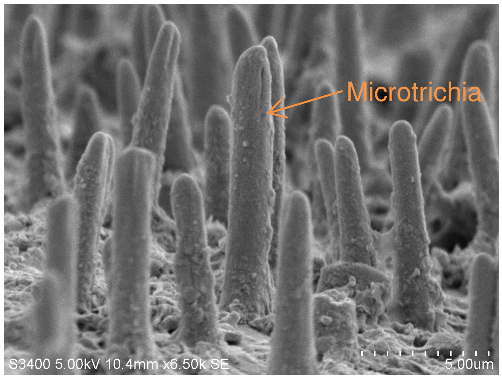

Figure 5: SEM micrograph 6.5k x magnification of epoxy resin surface

The micrograph in figure 5 clearly illustrates the 8μm long calcified microtrichia of the *Cancer pagurus* carapace surface that have been reproduced in epoxy resin.

Conclusions

The topography of the *Cancer pagurus* carapace shell has been translated into epoxy. The addition of the macroalgae extracts did not have an effect on the topography or contact angle of the surfaces.

The use of the more durable crustacean shell as a template for the topography has improved on the method presented in Chapman (2012)[4].

References

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