ASSESSMENT OF BIOFILM FORMATION ON NOVEL TRANSPARENT COATINGS FOR APPLICATION TO A LOW COST OPTICAL SENSOR DEPLOYED IN AN ESTUARINE ENVIRONMENT

C. Richards[1], C. Briciu-Burghina[1] Alan Barrett[1], and F. Regan[1] [1]School of Chemical Sciences, DCU Water Institute, Dublin City University, Glasnevin, Dublin 9, Ireland
Contact: chloe.richards3@mail.dcu.ie

Introduction

Water quality monitoring using autonomous sensors suffers many challenges in the aquatic environment of which biofouling is one that impacts cost of maintenance and data quality and integrity. In high fouling season, sensors often require maintenance and cleaning every two weeks adding significant cost to the monitoring programme. [1] Here we present a study in which we assess the abundance and diversity of biofouling organisms present on glass panels coated with novel transparent coatings for optical sensors. Diatom assessment was used to determine the effectiveness of the transparent coatings against biofouling. Test panels were deployed in the marine environment in Galway Bay for six months. Successful coatings can be applied to LEDs or optical windows to be tested and evaluated in terms of data quality and antifouling performance.

Experimental Location and Panels Deployed

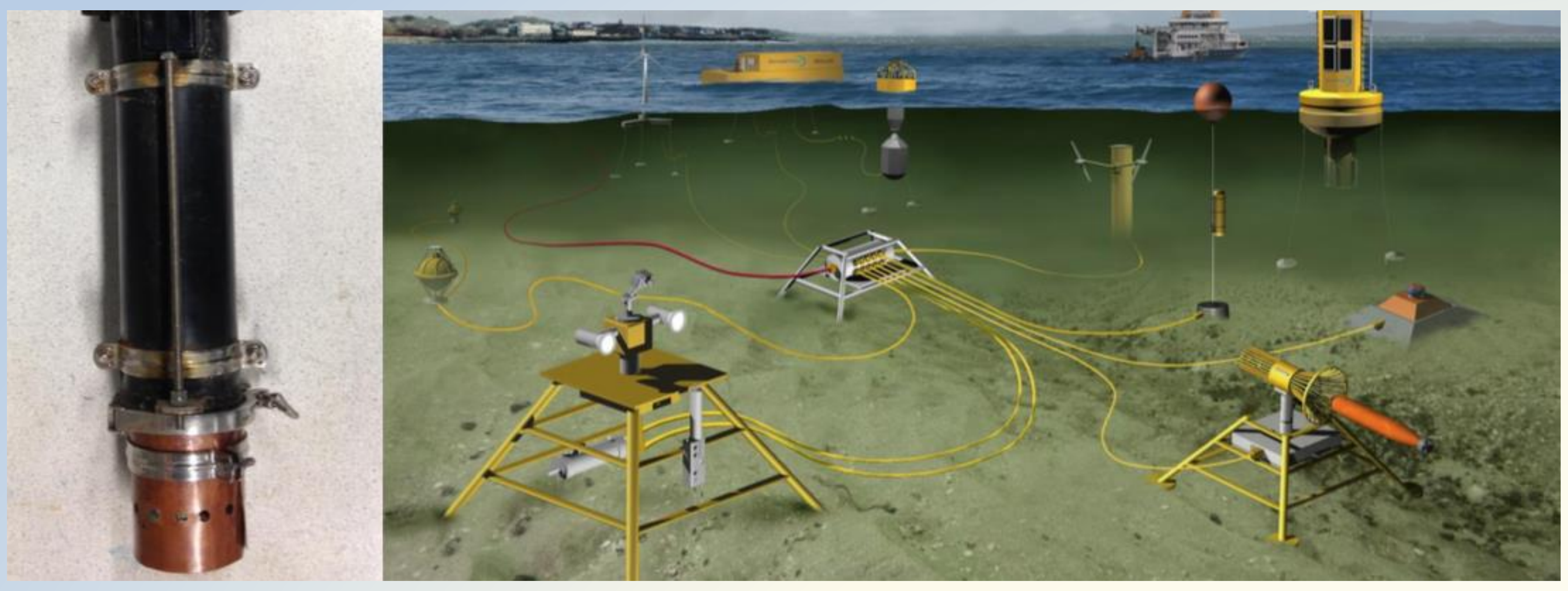


Figure 1 (Left) Shows the Optical Colorimetric Sensor head covered in copper for antifouling. (Centre) Galway Bay observatory where panels were deployed and (Right) Panels deployed

The location selected for this experiment was Galway Bay, County Galway, Ireland. Microscope slides coated with commercial paint (Trilux as control) and novel transparent antifouling coatings were deployed for six months to assess biofilm growth.

Sol-gel based materials of a variety of compositions were tested. The sol-gel materials were prepared using tetraethylortho silicate (TEOS), triethoxy(ethyl) silane, ethoxytrimethyl silane, triethoxymethyl silane, hexamethyldisilazane and chlorotrimethylsilane (CTMS) to achieve a variety of hydrophobicities, robustness and transparencies. Coatings were sprayed onto glass slides and attached to the panel for deployment in Galway Bay. Figure 2 outlines the panels appearance before and after deployment in Galway Bay. [Top left]: panel coated with commercial paints and novel transparent coatings before deployment. [Top Right]: Panel after deployment. [Bottom Left and Right]: Biofilm growth on panels in Galway Bay during the time of deployment.

Results and Discussion

Table 2 shows the genus of diatoms present on each of the novel transparent coatings and commercial paint deployed in Galway Bay after six months. The + indicates the genus present on the glass slides. The table below shows the types of diatoms identified over the course of this study.

In general, the diatoms were not found in cluster colonies but rather individually.

Identification of diatoms using Scanning Electron Microscopy

For the identification of diatoms using SEM, a glass slide from each transparent coating was prepared using a gold sputter coater. The samples were coated for 30 s before being analysed under SEM. At 5 kV and 1 mm and 20 kV and 10 µm, images of the various diatom species were taken and identified to species level using a diatom identification key. Figure 3 below shows the biofouling organisms present on the glass slides deployed in Galway Bay for six months.

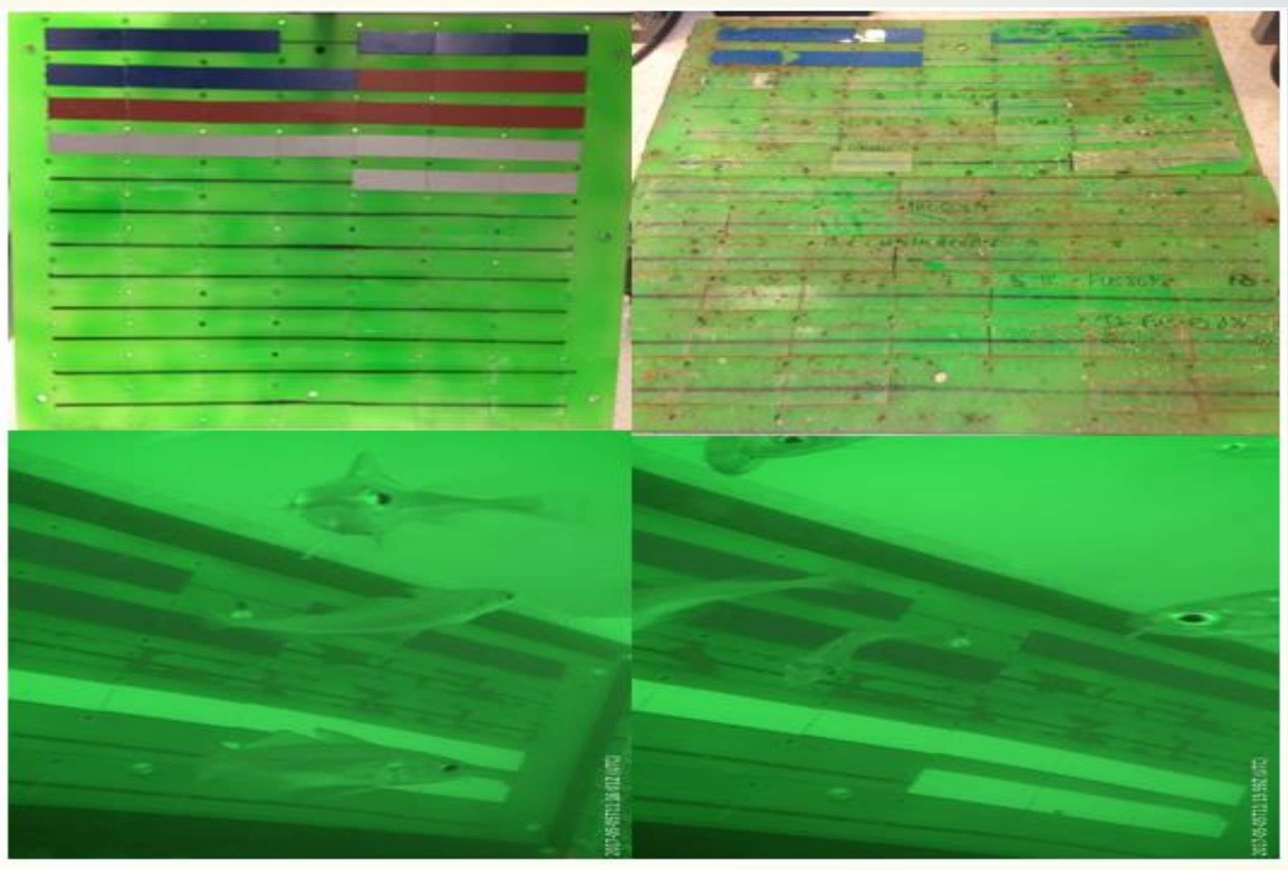


Figure 2: Panels deployed in Galway Bay

Top left: Before deployment; Top Right: Following retrieval of panels after 6-months;

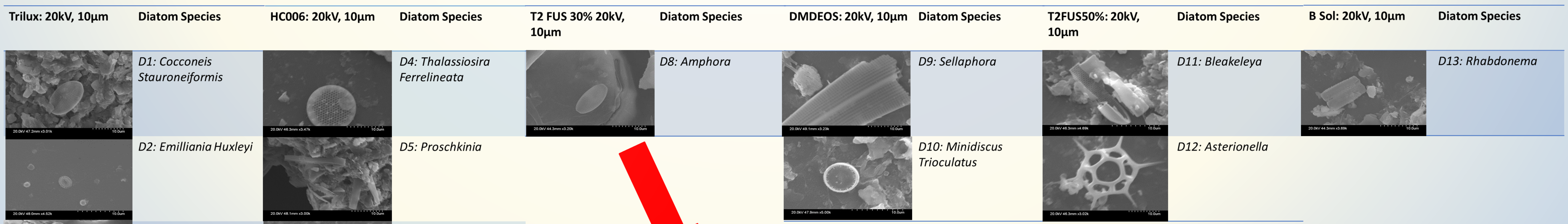
Bottom panels: Camera images taken of the panels during deployment showing progressive fouling.

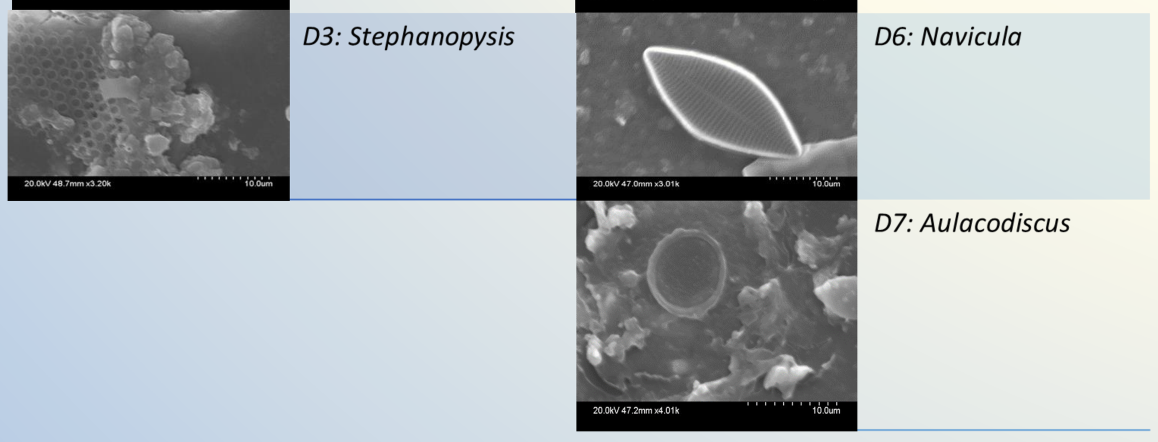
DIATOM GENUS /COATING	TRILUX	HC006	B SOL	DMDEOS	T2 FUS 50%	T2 FUS 30%
Minidiscus		+			+	
Asterionellopsis		+		+		
Emilliania	+	+	+		+	
Lepidodiscus		+		+		
Azpeitia						
Cocconeis	+	+	+		+	+
Thalassiosira		+	+	+		
Diplomenora		+				
Aulacodiscus			+	+		
Sellaphora				+		
Proschkinia		+	+		+	
Navicula		+				+
Rhabdonema					+	
Asterionella					+	
Stephanopysis			+		+	
Amphora			+		+	+
Bleakeleya					+	

Table 2: Observed diatom settlement on coatings deployed in Galway Bay.

FUS = fumed silica coated on the surface of a sol-gel in order to modify the hydrophobicity of the coating while maintaining transparency.

Figure 3: summary of diatom identification and diversity assessment





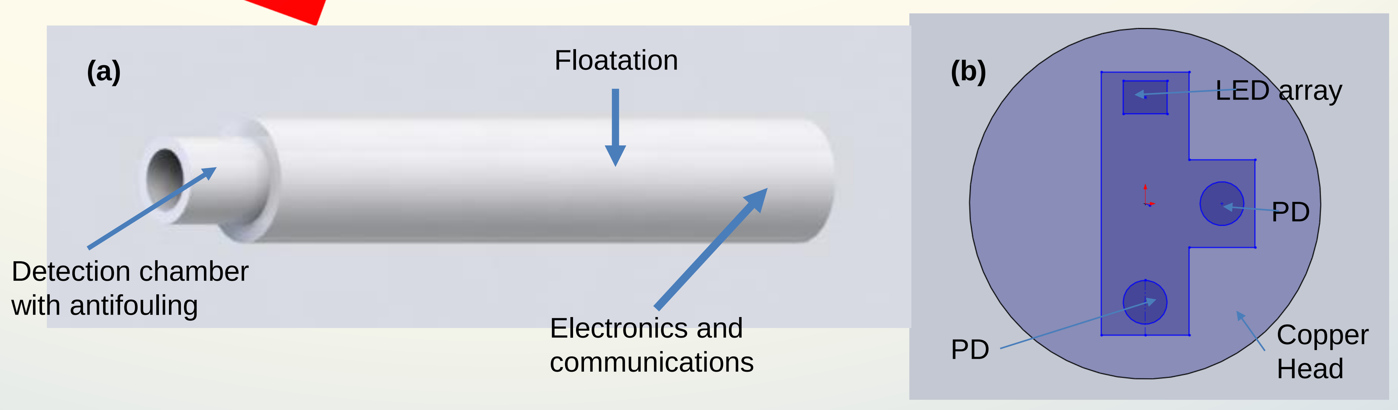


Figure 4: (a) A schematic of the optical LED based sensor body and LED configuration in the sensor head (b). LEDs require antifouling coating with T2 FUS 30%

Figure 5: Results of protein assay on coated slides. Highest levels of attachment on B Sol and lowest on DMDEOS.

Conclusions

- There was a low diversity of diatoms with most species listed occurring on the slides repeatedly. Cocconeis was found to occur on all materials (Figure 3).
- The novel transparent coating **T2 FUS 30%** was found to be the most effective coating demonstrating minimal biofilm adhesion when compared with the commercial paint, Trilux (Fig. 3).
- HC006 and DMDEOS coatings were found to contain a large diversity of species of diatoms and large numbers.
- This work leads to coating the LED-based optical sensors with the T2 FUS 30% transparent coating (Fig. 4).
- Results of protein bioassay identified less biofilm adhesion on all materials compared with B Sol (Fig.5).
- In relation to optical sensors in high fouling season, they often require maintenance and cleaning every two weeks adding significant cost to the monitoring programme, as well as compromised data.
- The initial biofilm formation occurs rapidly having an effect on the sensor measurements where the optical window or membrane is impacted by fouling organisms.

References: [1] K. Murphy, B. Heery, T. Sullivan, D. Zhang, N. O' Connor, D. Diamond, F. Regan, Low cost optical sensor for the monitoring of marine environments, Talanta, 2015, Jan; 132:520-7.

MESTECH Marine & Environmental Sensing Technology Hub
SMARTBAY IRELAND
Marine Institute Foras na Mara
DCU Water Institute