CHARACTERIZATION AND ANTIBIOFOULING EFFICIENCY PREDICTION IN FOULING-RELEASE COATINGS BASED ON PDMS

IX SIMPOSIO de Investigación EN CIENCIAS EXPERIMENTALES

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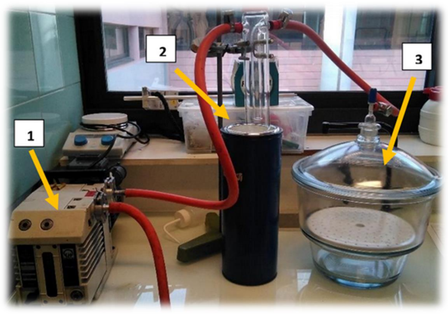
INTRODUCTION

Biofouling consists in the cell adhesion on a surface exposes to an aqueous environment. Nowadays, one of the main approaches for combating this phenomenon is preventing the fouling attachment. Techniques that are being investigated are mainly based on controlling physicochemical and mechanical properties (surface free energy, wettability, hydrophobic or hydrophilic character, elasticity and surface topography), which impact on the interaction between organisms and the surface. On the one hand, siloxanes (hydrophobic), specifically polydimethylsiloxane (PDMS), possess antibiofouling properties due to their low surface energy, inertness, stability and flexibility. On the other hand, polymers based on polyethylene-glycol (PEG) (hydrophilic), revealed significant antibiofouling properties; and especially, a significant resistance by theses surfaces to protein attachment. On the contrary, amphiphilic copolymers are composed of both hydrophobic and hydrophilic functional groups, and due to this dual behavior, the adherence of exopolymeric substances (EPS), as proteins or polysaccharides, bacteria and marine algae becomes energetically unfavorable, thereby weakening the interaction of the microorganisms with the surface[1,2,3]. To be able to manufacture a transparent fouling-release coating (FRC) with no cell adhesion in a long time period to built efficient closed-photobioreactor is a key factor to obtain the economic feasibility of a microalgae-based process.

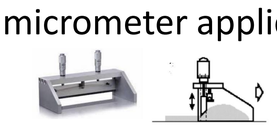
MATERIALS AND METHODS

- Additives used (CMS-626, DBE-224, DBE-311, DBE-621, DBE-814, DBE-821, DBE-921, DBE-C25) in 4% w/w and controls (Hempasil X_3®, PDMS (Sylgard® 184), glass) were prepared in 2 thickness (120 and 240 μm). 1200-OS and 92-023 Primers from Dowsil™. Bisphenol A Epichlorohydrin modified Epoxy paint (Mercapinturas).
- Vaccum system to remove the bubbles formed after PDMS and additive mixture.



1. Vacuum pump. **2.** Liquid nitrogen condensation to avoid contamination in samples. **3.** Desiccator where to place the sample to remove bubbles.

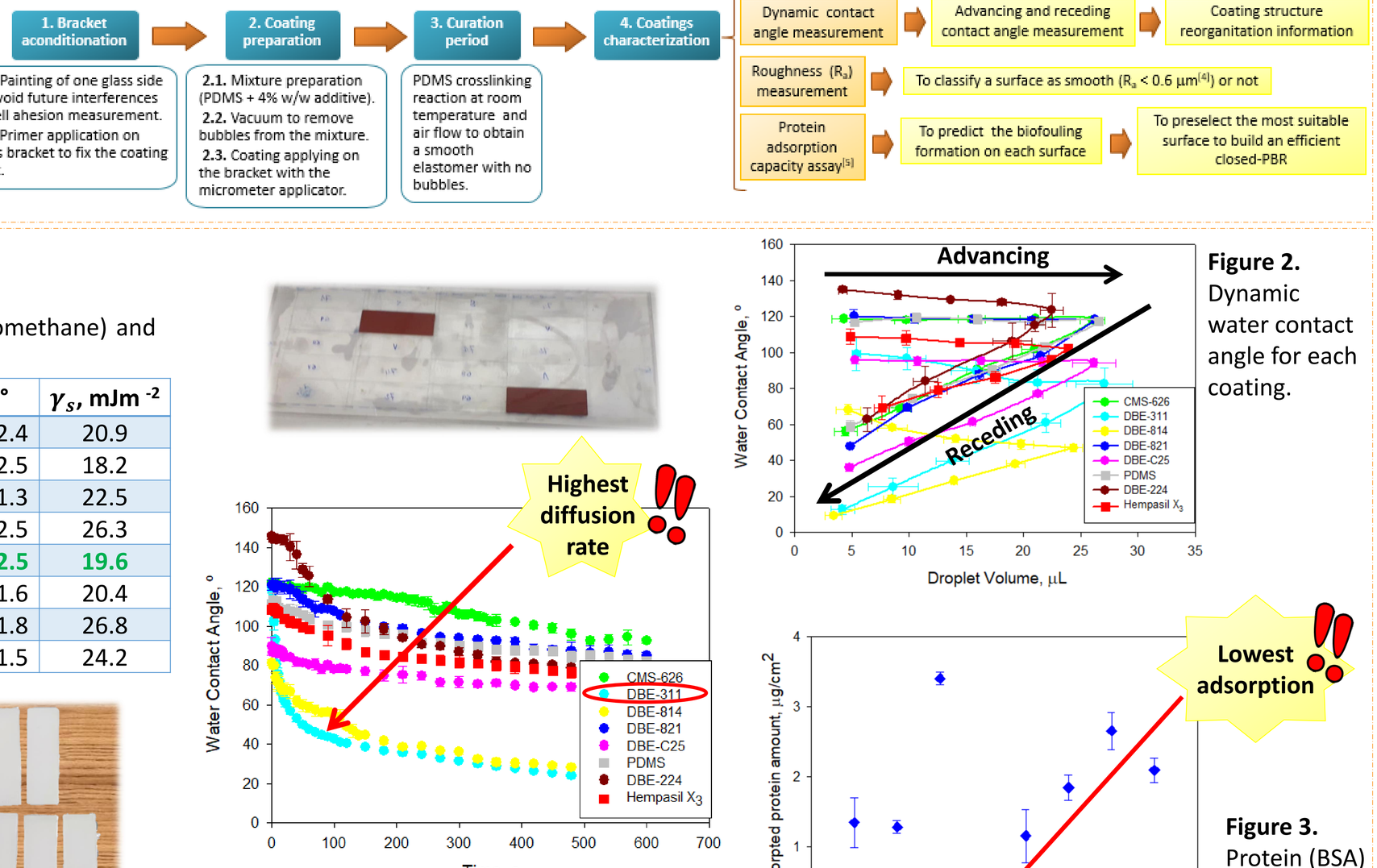
- Micrometer adjustable film applicator (3580/3 Universal micrometer applicator, Neurtek, Spain).



OBJECTIVES

The objective of this work was to obtain 8 non-toxic transparent FRCs based in PDMS prepared *via* hydrogel technology with antibiofouling properties capable to built an efficient closed-PBR with it. Two different primers (fixer) were investigated to select the most suitable to attach the coating on the glass .

- Goniometer (Drop Shape Analyzer DSA25, KRÜSS GmbH, Germany) and surface profiler (PCE-RT 11, PCE Ibérica S.L., Spain) to the surface characterization.



RESULTS AND DISCUSSION

Table 1. Contact angles (W-water, F-formamide, D-diiodomethane) and Surface Free Energy at initial state.

	R_a, μm	θ_W, °	θ_F, °	θ_D, °	γ_S, mJm $^{-2}$
DBE-224	0.06±0.03	122.5±4.9	120.3±4.0	87.2±2.4	20.9
DBE-821	0.05±0.01	120±1.5	106.9±1.8	81.8±2.5	18.2
DBE-C25	0.05±0.02	116.3±1.3	105.9±1.1	76.8±1.3	22.5
DBE-814	0.03±0.01	80.4±2.0	98.3±3.7	89.8±2.5	26.3
DBE-311	**0.05±0.02**	**118.4±2.0**	**111.4±2.0**	**78.9±2.5**	**19.6**
CMS-626	0.05±0.02	119.5±1.7	105.2±1.5	77.5±1.6	20.4
PDMS	0.06±0.02	111.8±1.1	113.5±2.3	81.8±1.8	26.8
X3	0.07±0.03	107.3±1.0	106.1±5.4	81.3±1.5	24.2

Table 2. Primers efficiency to fix the different coatings cured on glass surface.

Thickness	Additive	Without Primer	1200-OS	92-023
120 μm	DBE-224	✗	✗	✓
	DBE-821	✗	✗	✓
	DBE-C25	✗	✗	✗
	DBE-814	✗	✓	✓
	DBE-311	✓	✓	✓
	CMS-626	✗	✗	✗
	PDMS	✗	✓	✓
	DBE-621	Not cured after 3 months		
	DBE-921	Not cured after 3 months		
240 μm	Not cured yet			

Symbol	Meaning
✓	Coating not detached from the glass bracket
✗	Coating detached from the glass bracket

Figure 1. Water contact angle evolution over time for each surface.

Figure 2. Dynamic water contact angle for each coating.

Figure 3. Protein (BSA) amount adsorbed for each surface.

CONCLUSIONS

- ✓ **92-023 Primer (Dowsil™)** seems to be the **most suitable** fixer for the coatings elaborated.
- ✓ Additives **DBE-621** and **DBE-921** negatively **influence** the **crosslinking** reaction, **inhibiting** the **curing reaction**.
- ✓ **DBE-311** has the **highest diffusion** rate among all the coatings tested**.**
- ✓ **DBE-311** presents the **lowest protein adsorption** among all the coatings tested.
- ✓ **DBE-311** is the additive **selected to build an efficient closed-PBR**, **followed by DBE-814 and CMS-626**, because of the **low protein adsorption.**

REFERENCES

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