Antifouling for non-paintable flexible polymers



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CSIRO Energy Flagship

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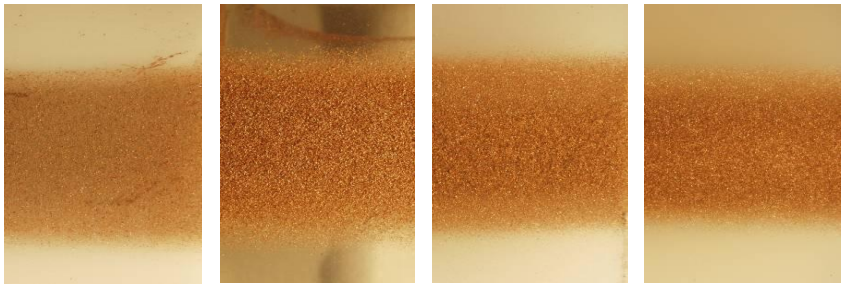
Background

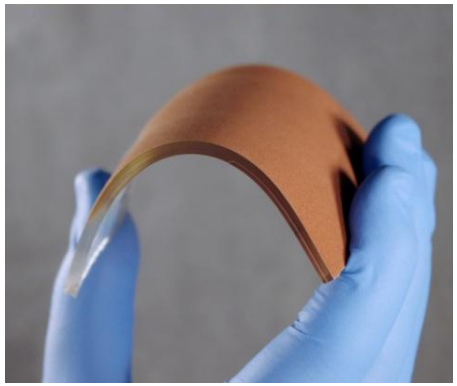
CSIRO together with James Cook University have developed a new antifouling process suitable for non-paintable flexible polymers.

The technique embeds antifouling particles into the surface of the polymers. Typically particles are copper metal or similar.

The process has been developed to the generic level and requires refining for each new application.

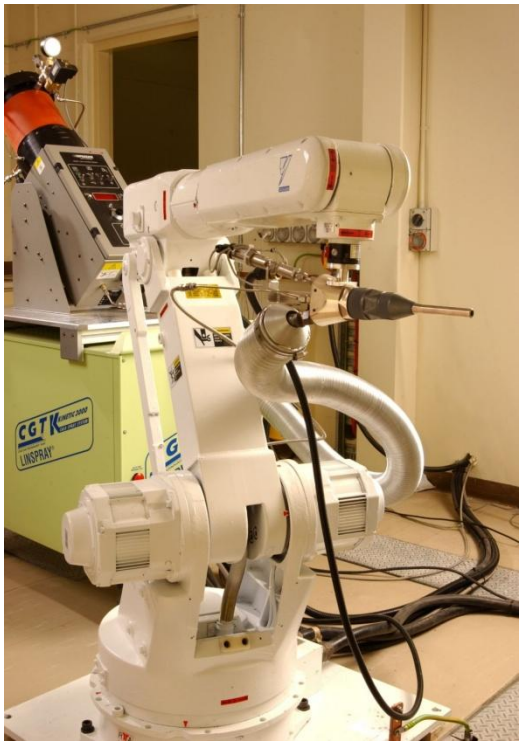


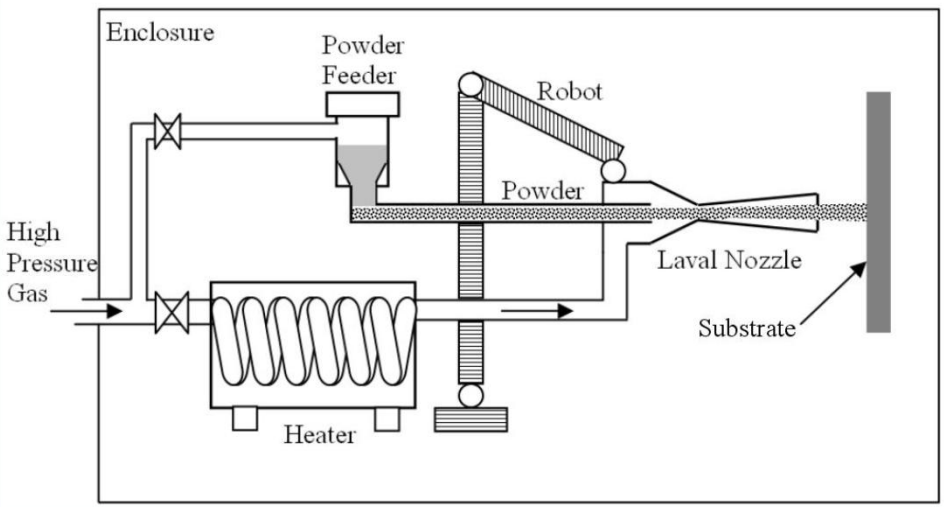
Nylon Polyurethane HDPE Teflon



Polyurethane - seismic streamer jacket

Particles are embedded using Cold Spray

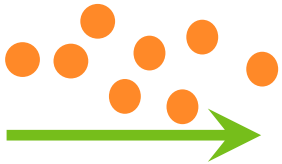


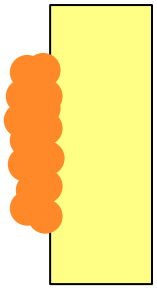


Dymet
CGT Kinetiks 4000
Plasma Giken

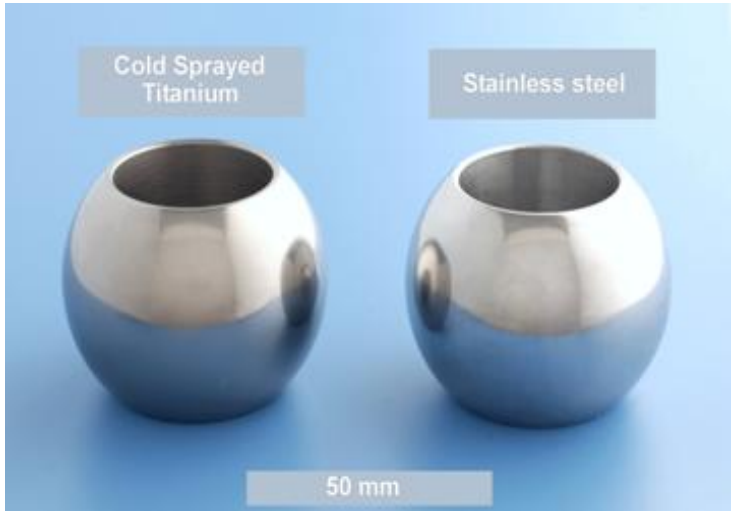
Cold spray paradigms

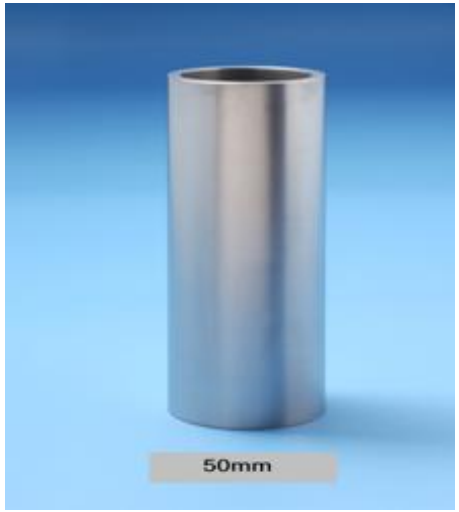
Conventional metal-on-metal cold spray, above critical velocity





Forms strong metallic bonds





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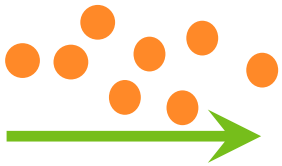
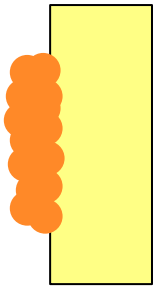
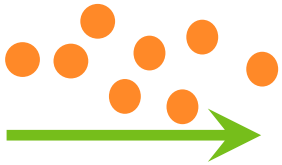
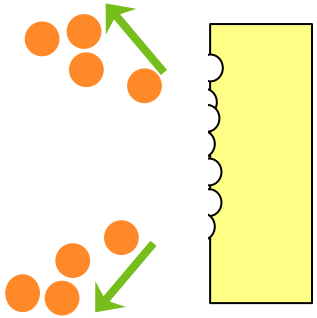




Forms strong metallic bonds

Below critical velocity, abrades surface or rebounds

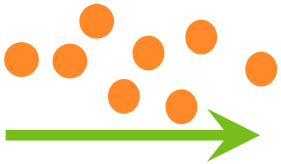


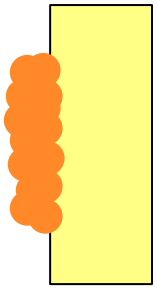


Non-adherence

Cold spray paradigms

Conventional metal-on-metal cold spray, above critical velocity





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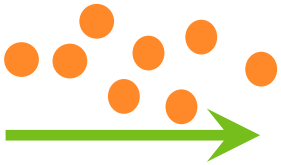
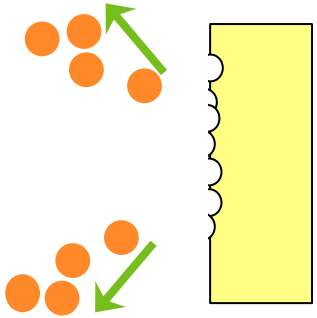
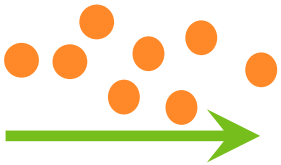


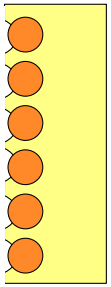


Non-adherence

Our system is a new paradigm

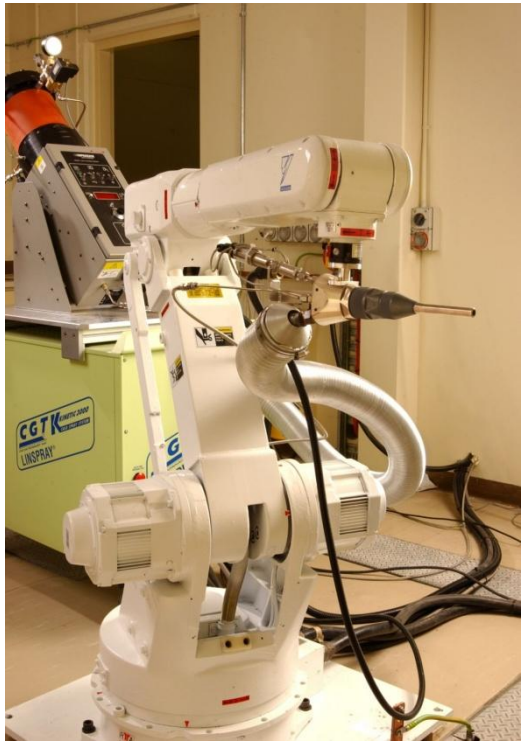
Careful selection of velocity, heat and materials





Embeds particles

Antifouling using Cold Spray Embedment



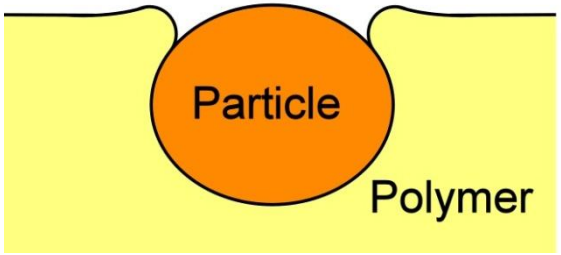
Deposit particles into polymer surface

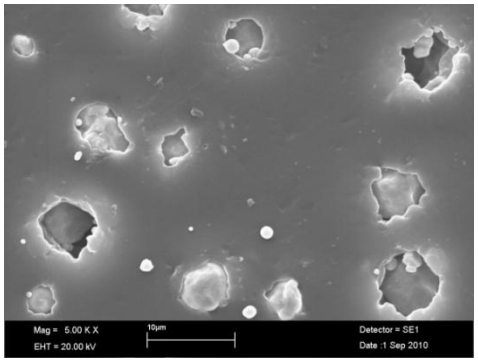
High velocity spray, 300 – 1200 m/s

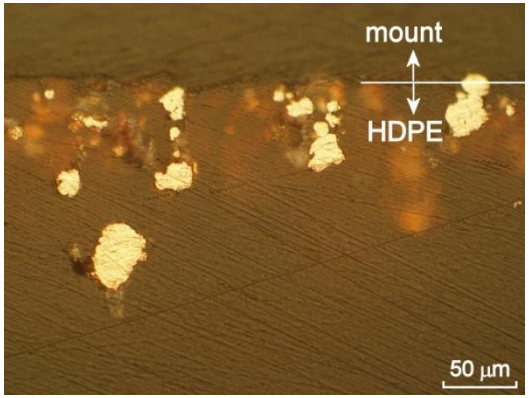
Thermoplastic polymers

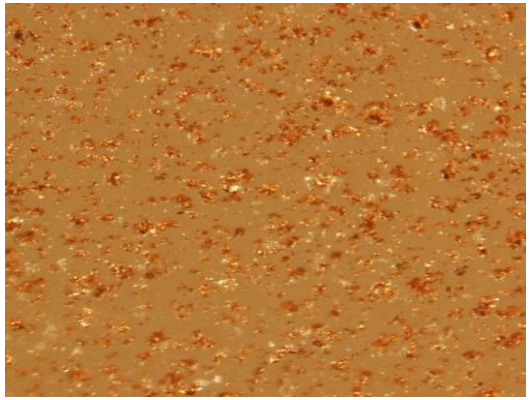
Discontinuous layer

Patent







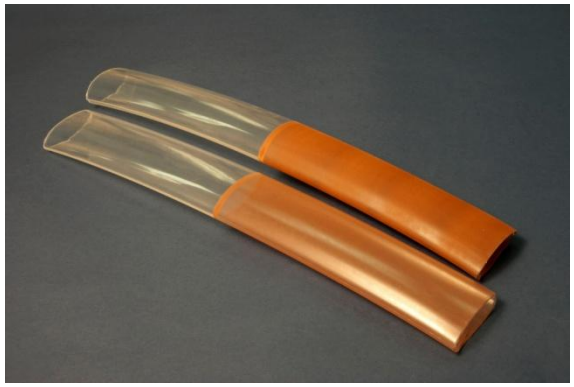


Poole et al. 2012 WO 2012/006687

Coating performance

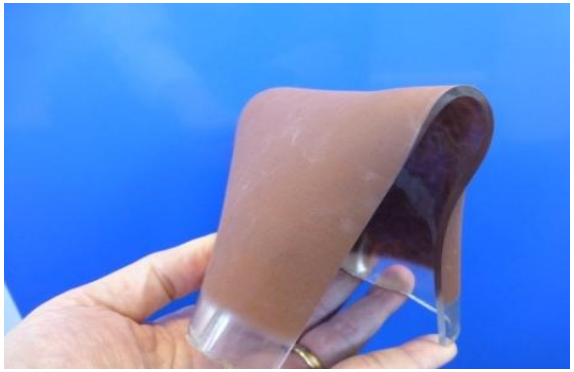
Coating characteristics

- Suitable for low surface energy polymers
- Can coat perforated, expandable, flexible polymers
- Layer cannot crack or delaminate

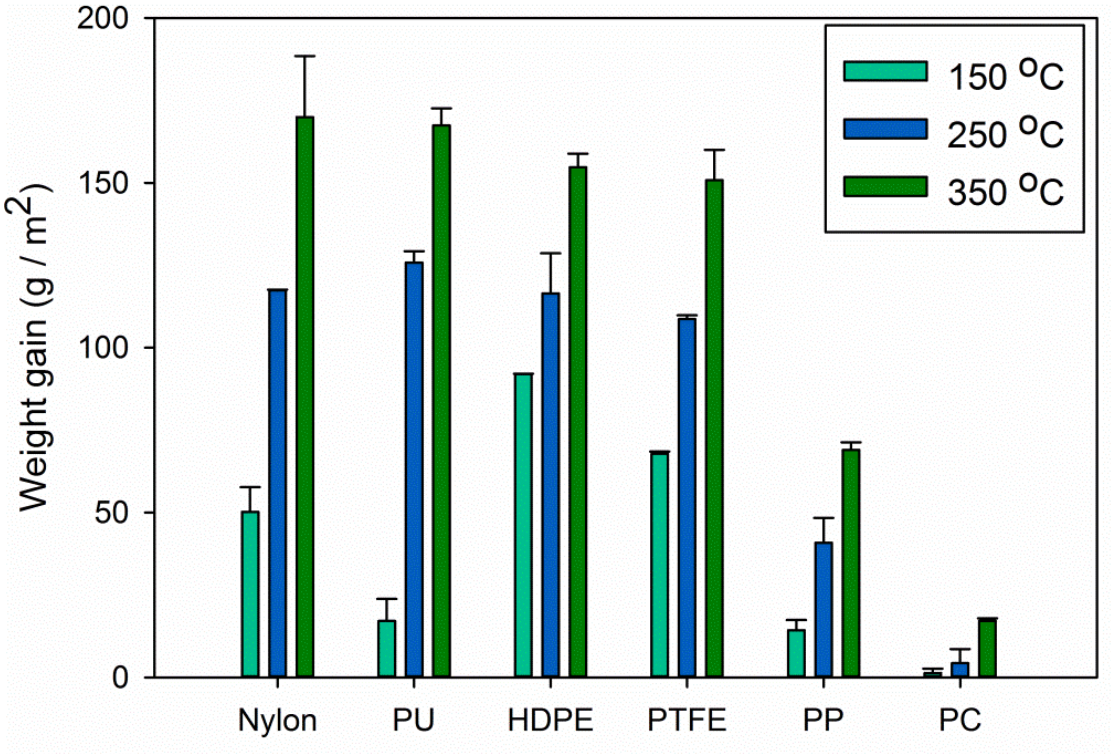


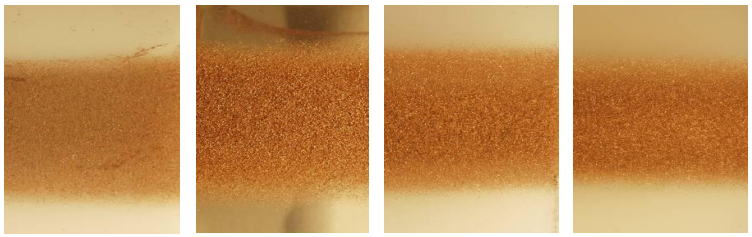
Minimal change in bulk polymer properties

- Minimal change in modulus, hardness
- Surface not electrically conductive
- Surface roughness increased
- Often increased surface friction



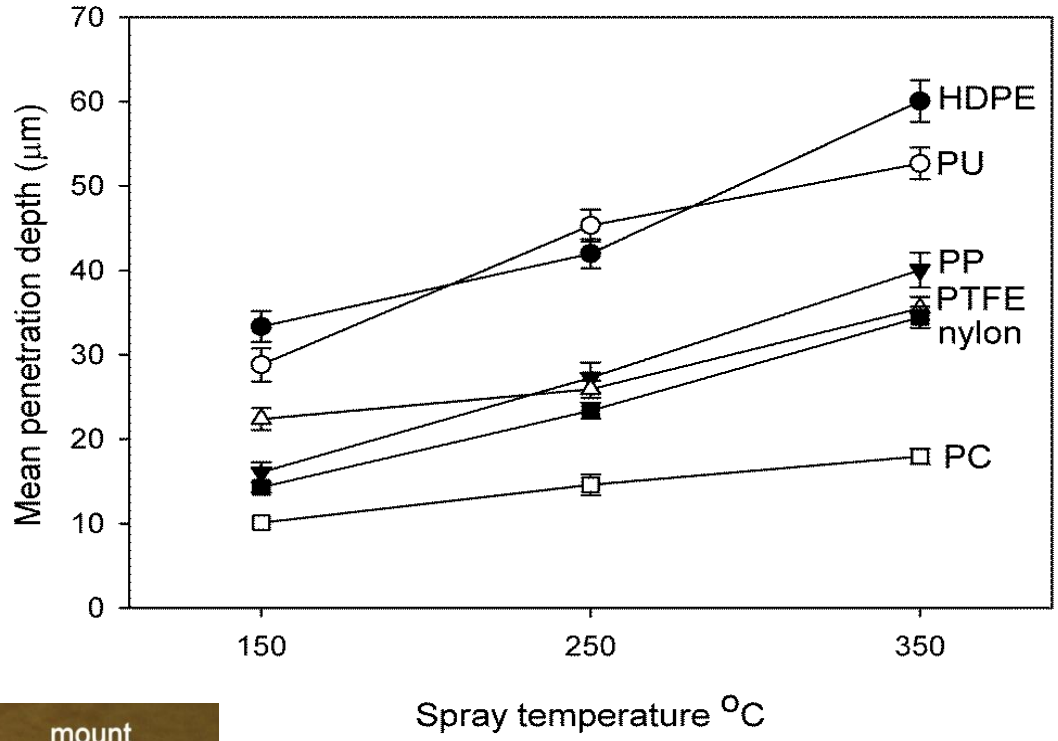
Material and Particle Interaction

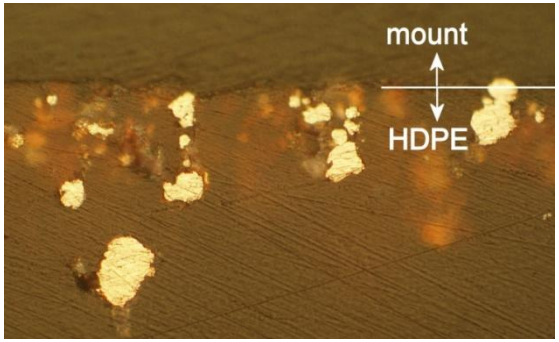




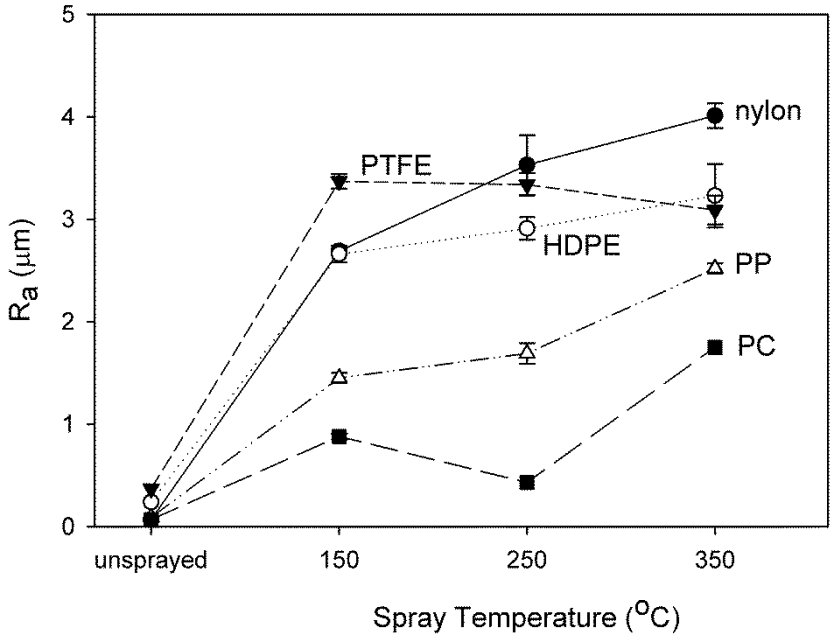
Nylon **Polyurethane** **HDPE** **Teflon**

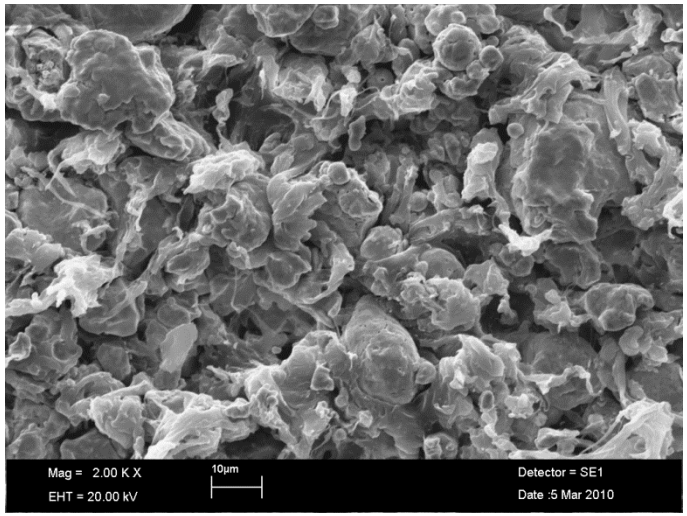
Material and Particle Interaction





Roughness



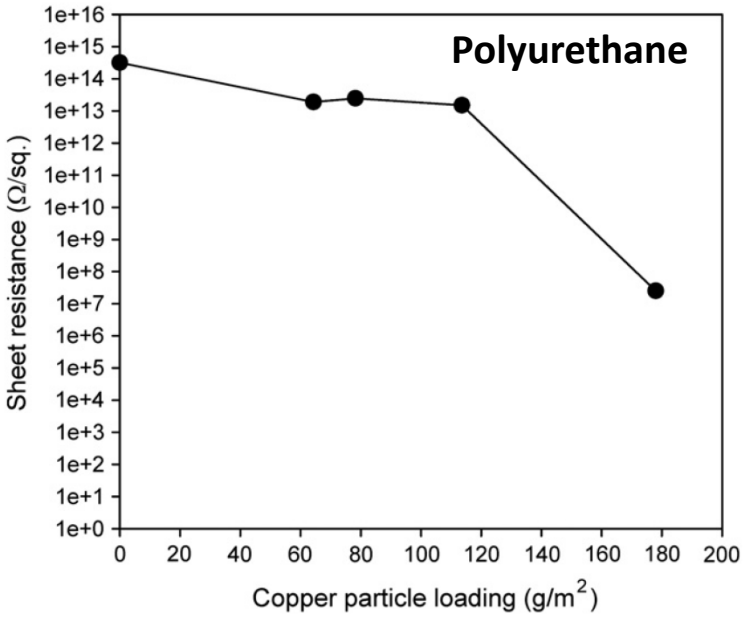


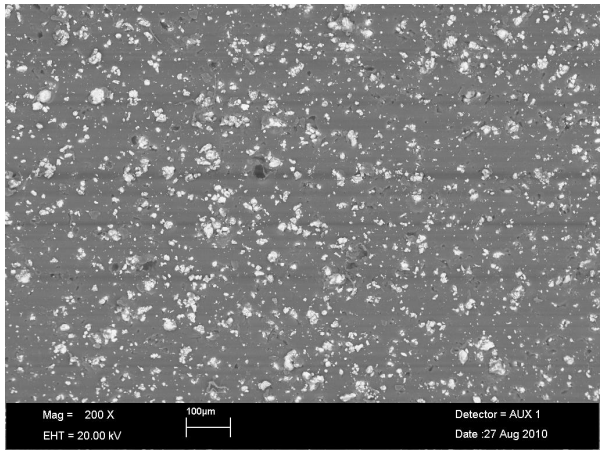
Nylon after cold spray

Self-friction

Test Material	Copper Loading (g/m^2)	Static Friction Co-efficient
HDPE	Control	0.35
	238.5	0.53
Nylon 6	Control	0.26
	192.6	0.76
Polyurethane	Control	1.97
	288.7	0.94
Teflon	Control	0.15
	143.2	0.65

Electrical Conductivity



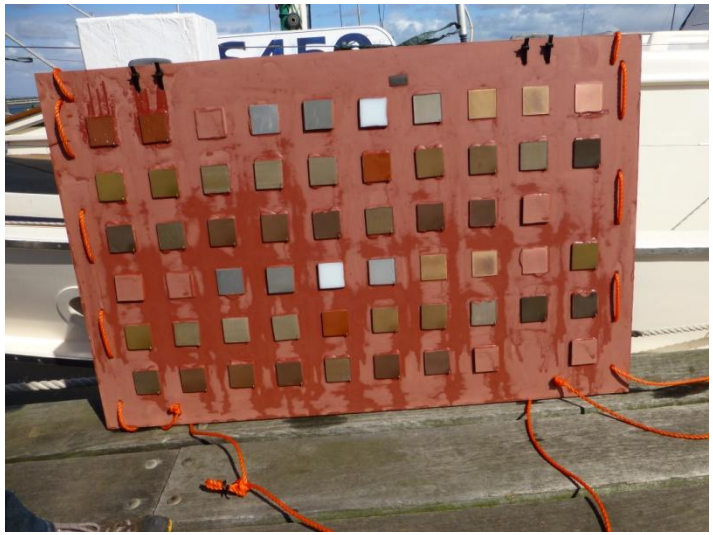


Back scattered electron image

Optical micrograph

Biological Testing

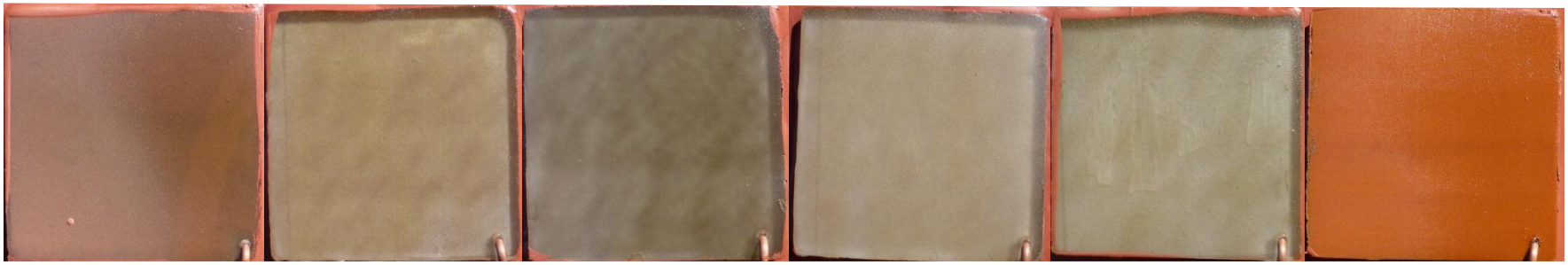
Queenscliff Cruising Yacht Club, Victoria



Day 2 Controls:

Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments

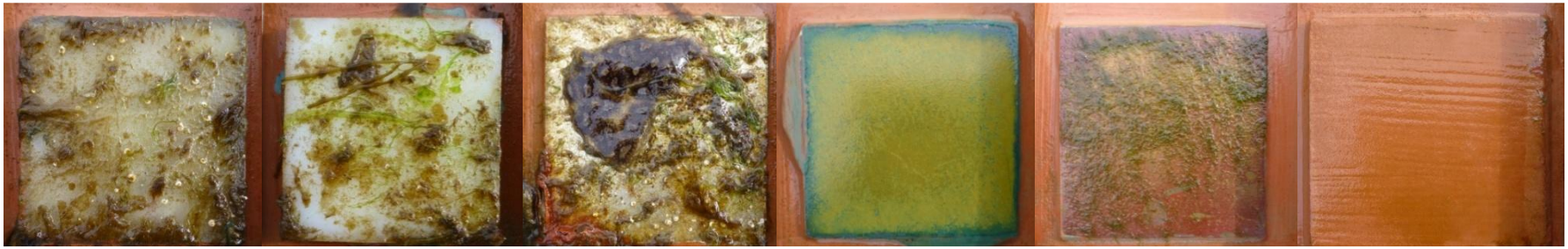


A B C D E F

Higher-level treatments

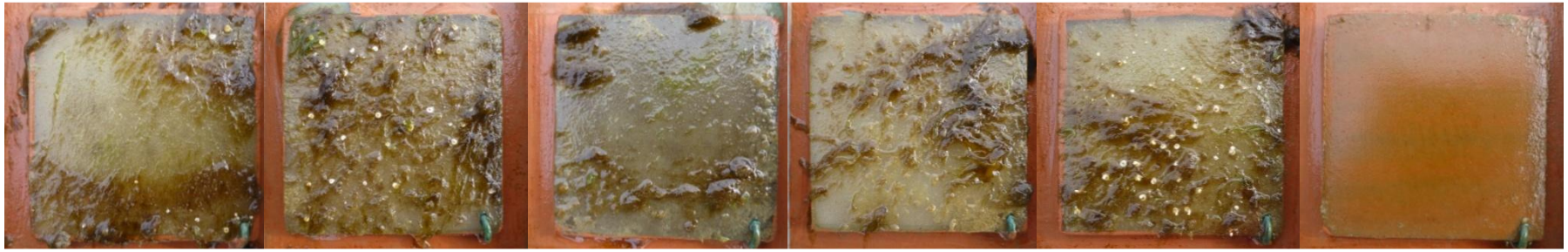
A B C D E G

Day 162 Controls:



Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments

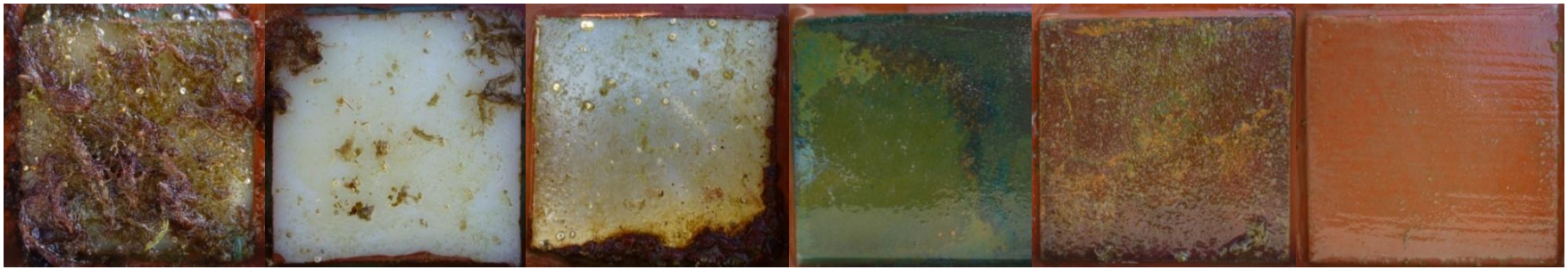


A B C D E F

Higher-level treatments

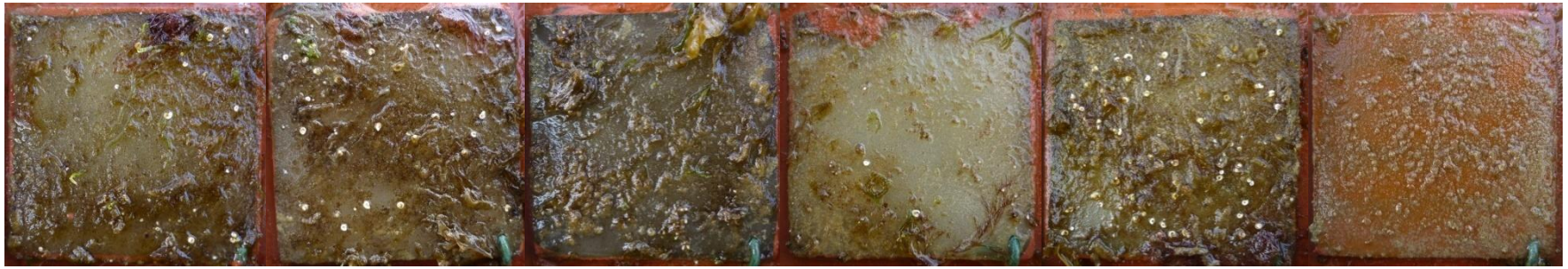
A B C D E G

Day 240 Controls:



Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments

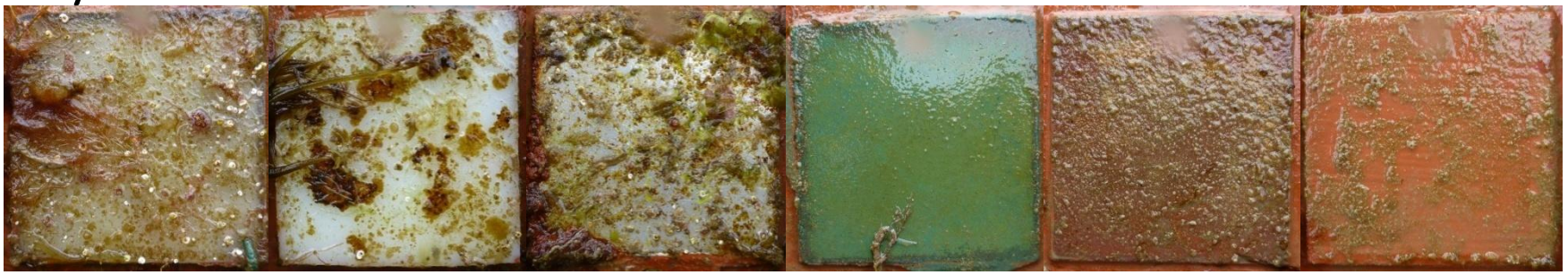


A B C D E F

Higher-level treatments

A B C D E G

Day 287 Controls:

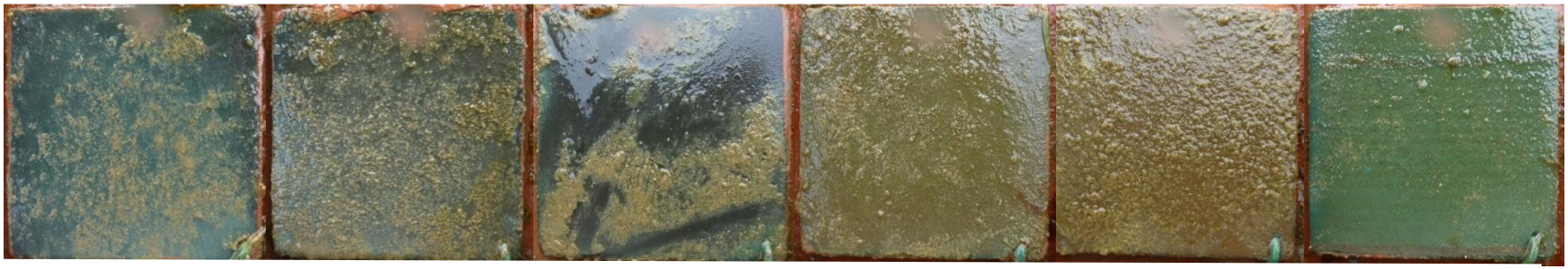


Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments

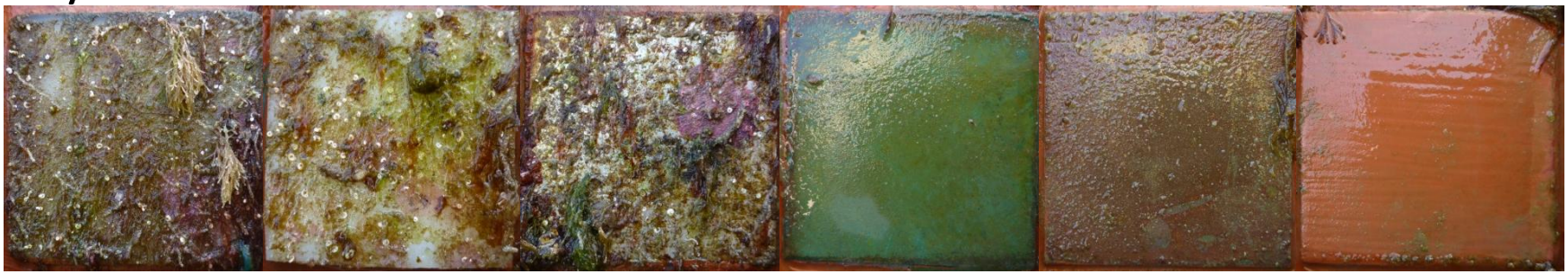
A B C D E F

Higher-level treatments



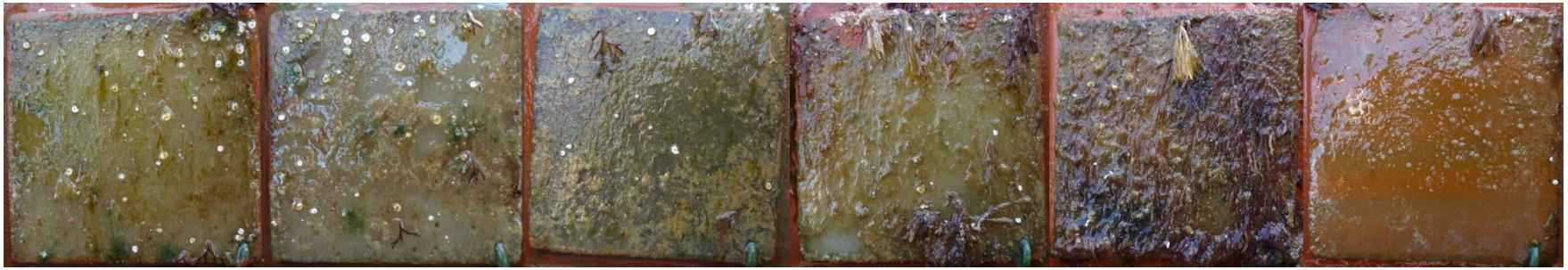
A B C D E G

Day 357 Controls:



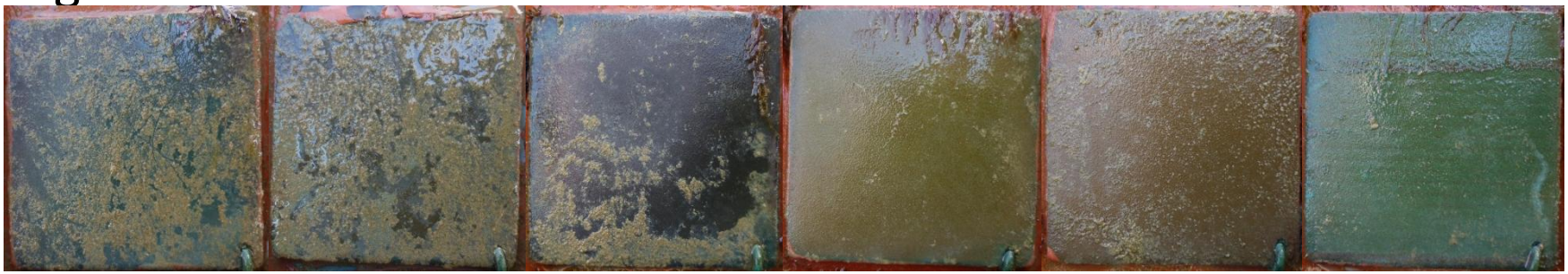
Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments



A B C D E F

Higher-level treatments

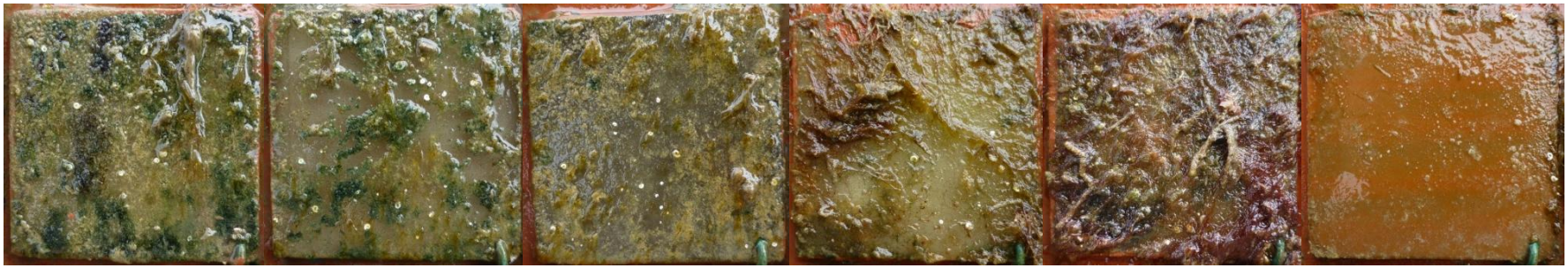


A B C D E G

Day 397 Controls:

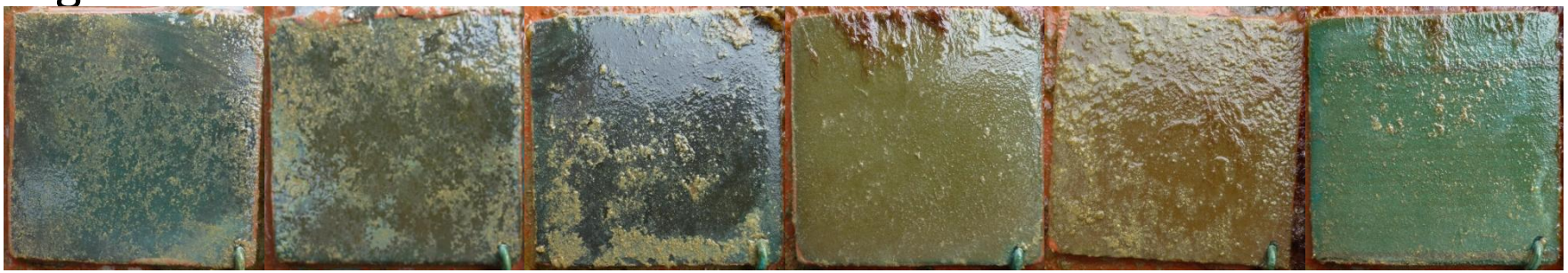
Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments



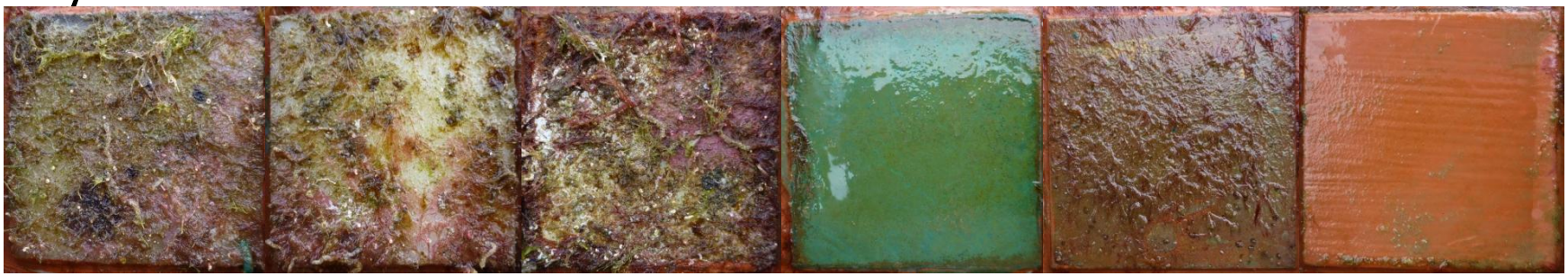
A B C D E F

Higher-level treatments



A B C D E G

Day 453Controls:

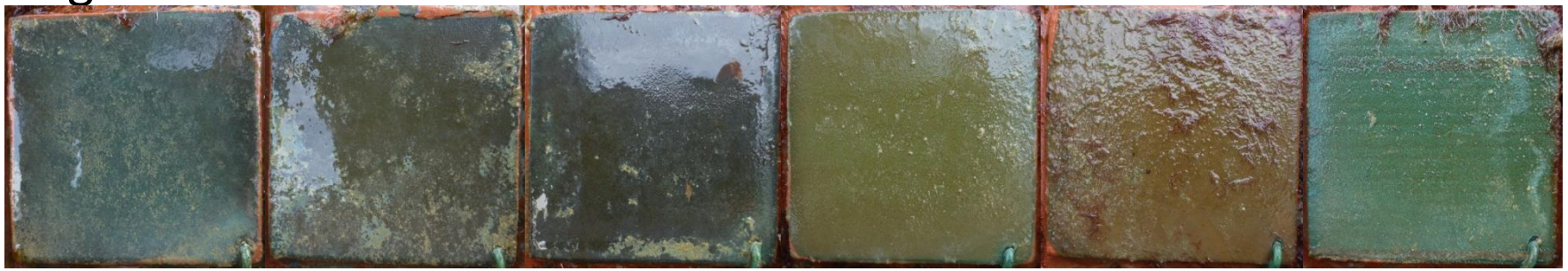


Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments

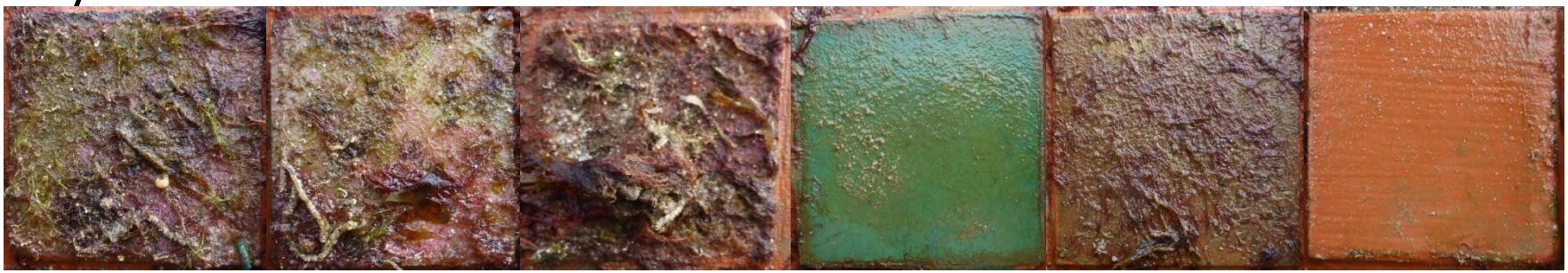
A B C D E F

Higher-level treatments



A B C D E G

Day 511 Controls:



Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

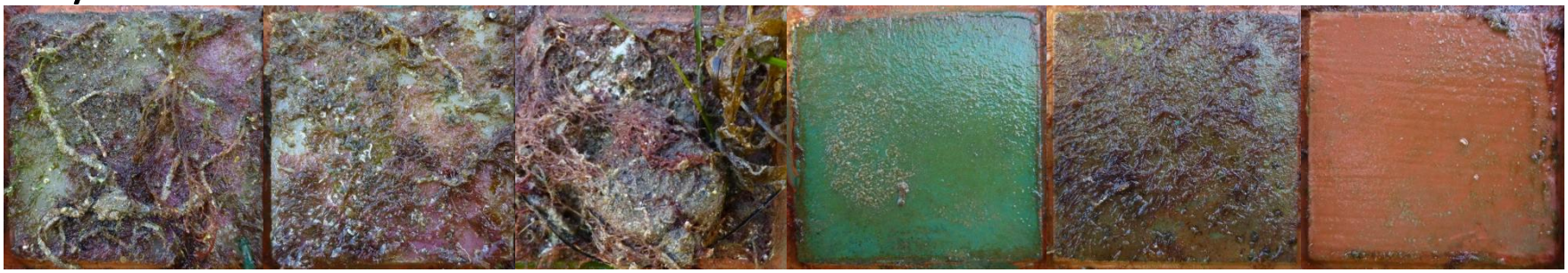
Low-level treatments

A B C D E F

Higher-level treatments

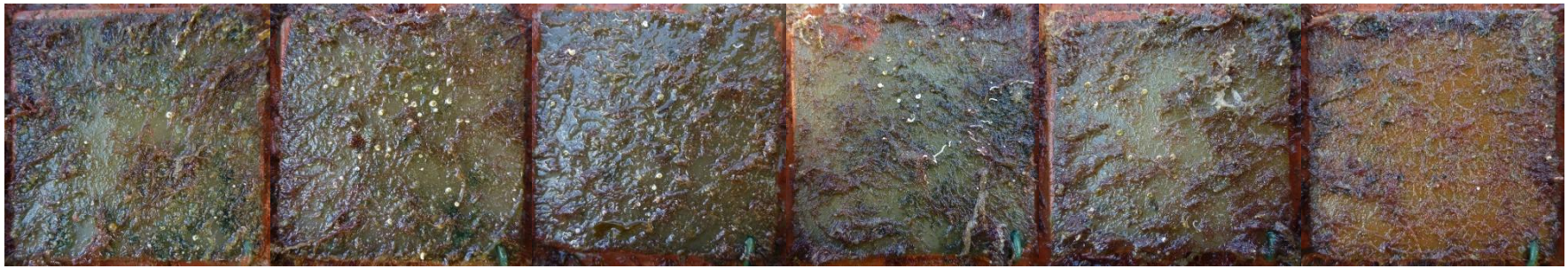
A B C D E G

Day 562 Controls:



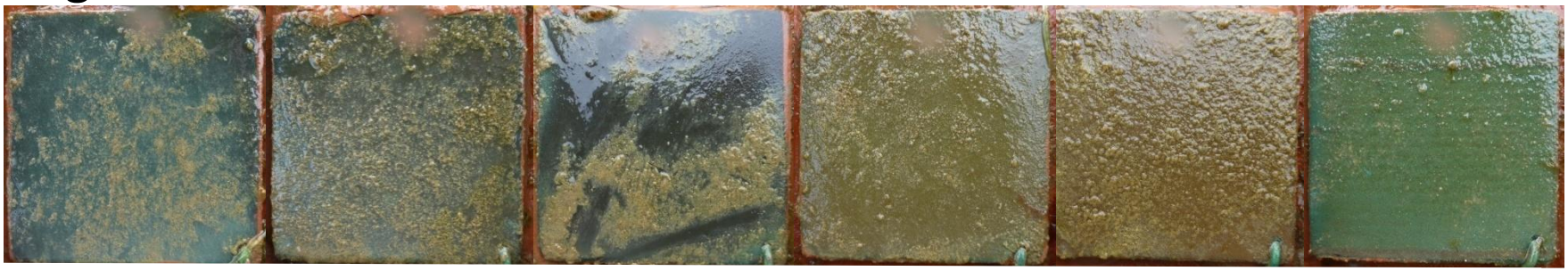
Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments



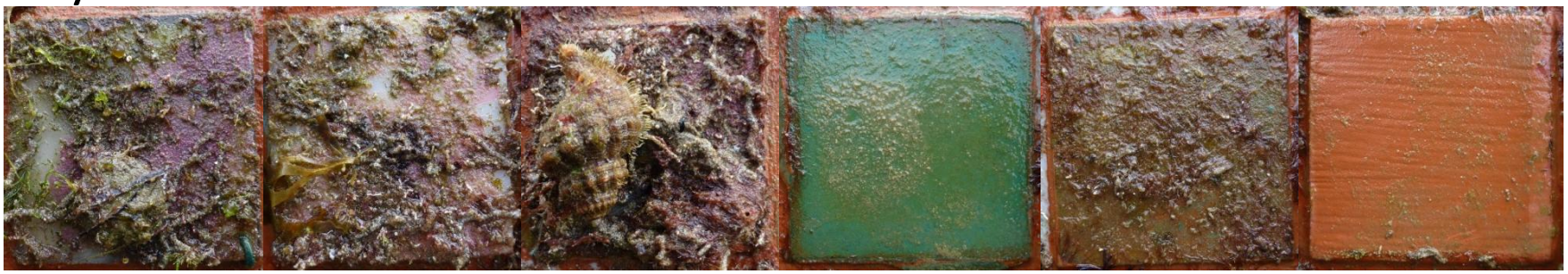
A B C D E F

Higher-level treatments



A B C D E G

Day 616 Controls:

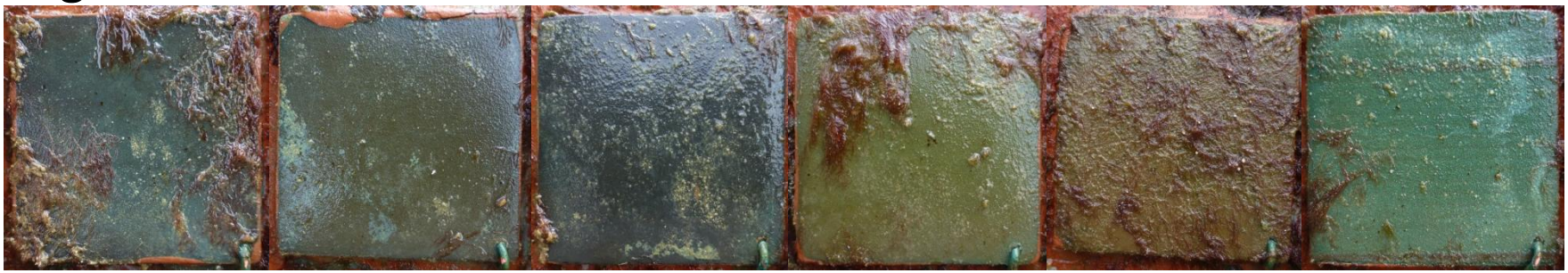


Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments

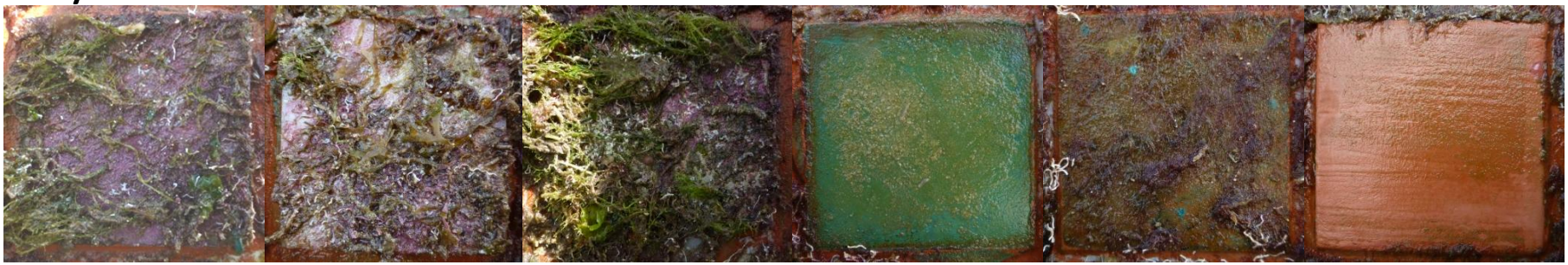
A B C D E F

Higher-level treatments



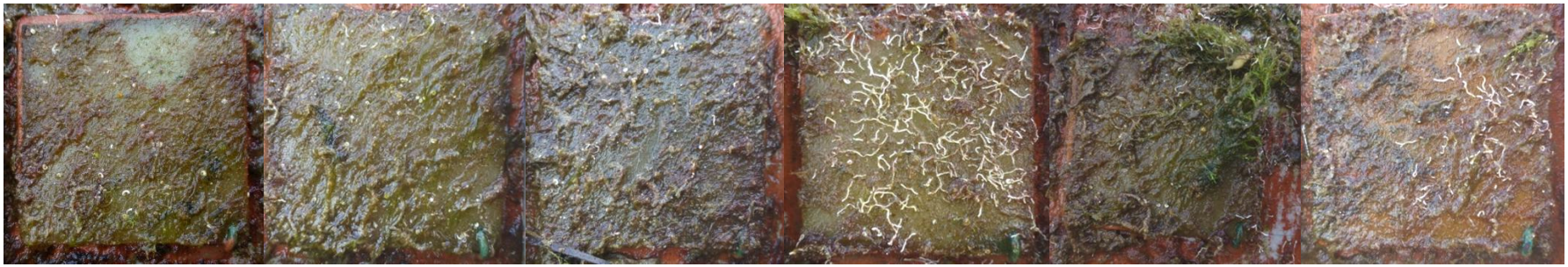
A B C D E G

Day 719 Controls:



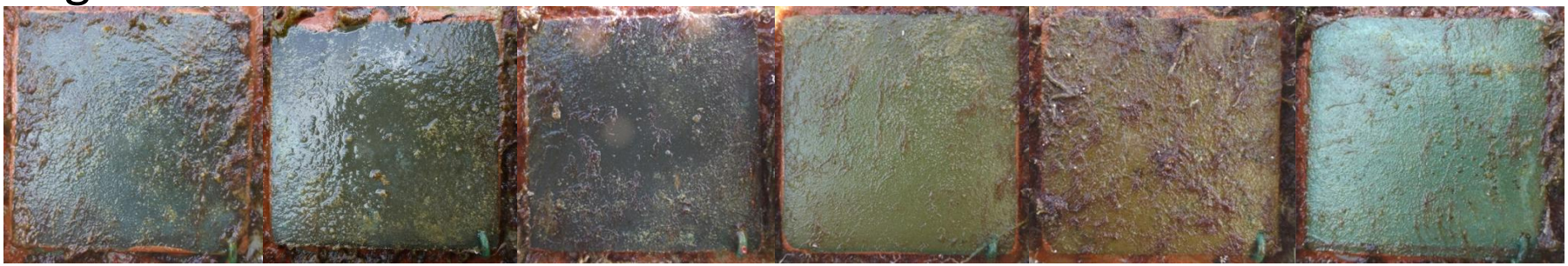
Polyurethane HDPE Stainless steel Copper Bronze Antifoul paint

Low-level treatments



A B C D E F

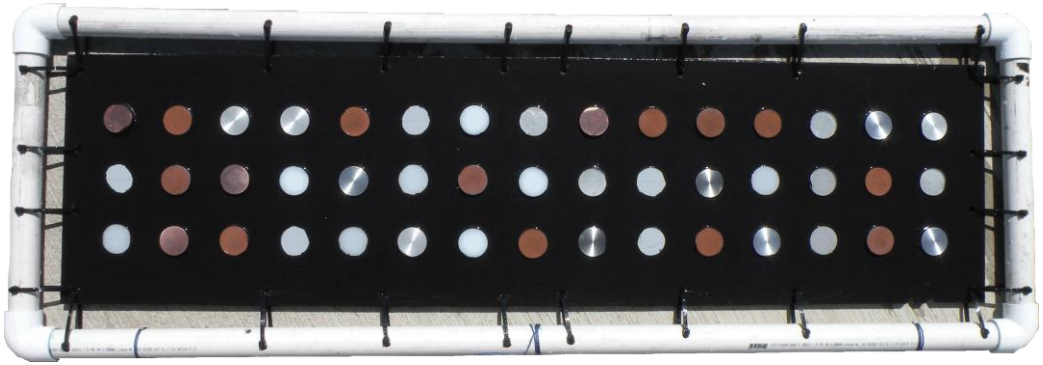
Higher-level treatments



A B C D E G

Field Testing

Tests carried out in Townsville harbour, tropical North Queensland



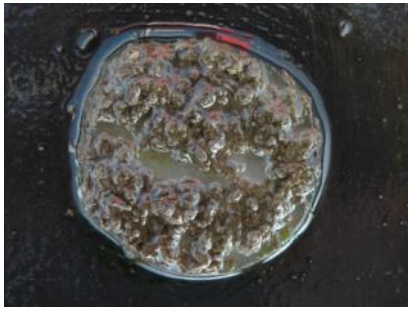
Perspex Control

Aluminium

Stainless Steel

Titanium

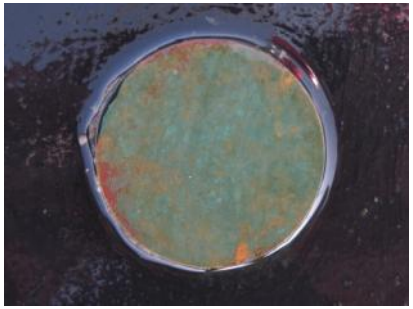
110 days



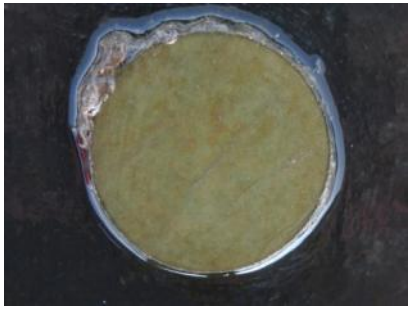
Polymer 1

Polymer 2

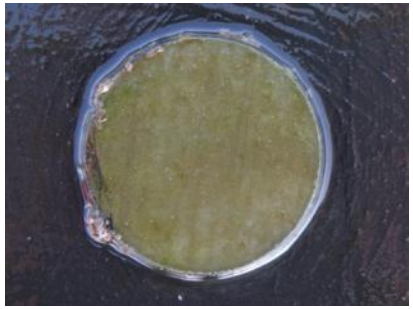
Polymer 3



Copper



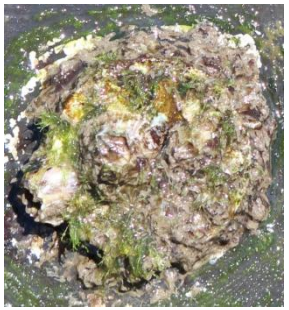
Treated Polymer 1



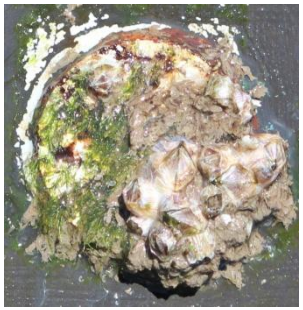
Treated Polymer 2

Treated Polymer 3

Perspex Control



Aluminium

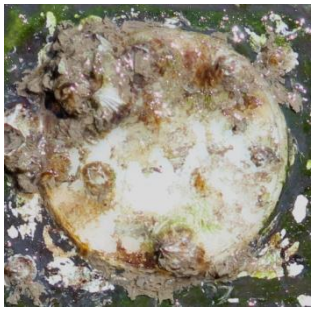


Stainless Steel

Titanium

600 days

Polymer 1

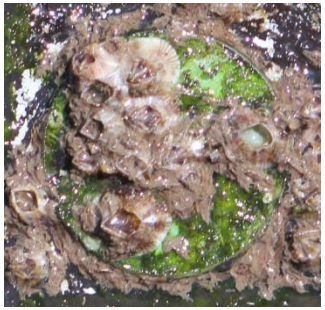


Polymer 2

Polymer 3

Copper

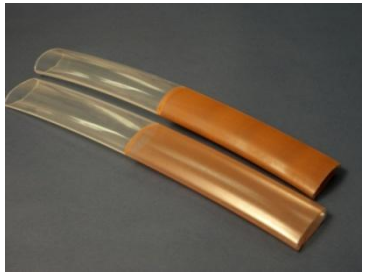
Treated Polymer 1



Treated Polymer 2

Treated Polymer 3

Seismic streamer jacket



54 days

146 days

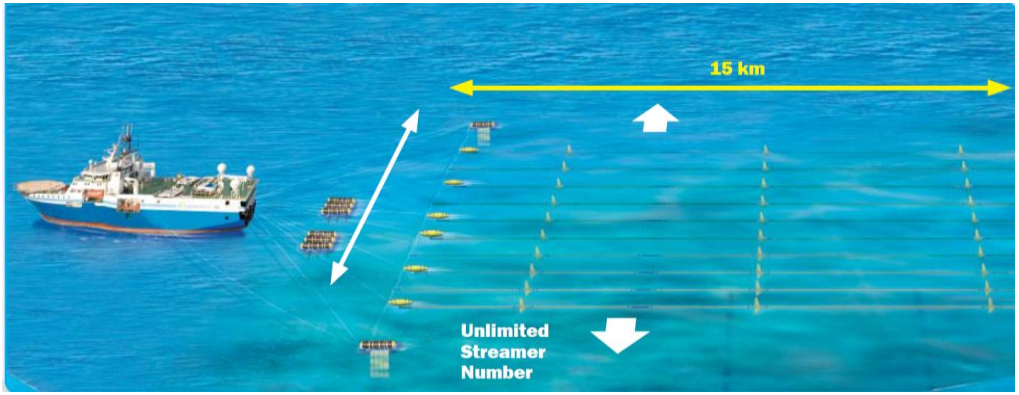
210 days

Example application

Seismic streamers -

Geophysical surveys for oil and gas

$1-1.5 million per vessel per year
Data quality
OHSE



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Thank you

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