

# How we're giving ships a cloak of invisibility

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# The sea is the most important transportation route for global trade

**Roughly 90 percent  
of global freight  
is transported by sea**

**Over 50,000 freighters are in  
operation around the world**

**Cargo capacity of these ships  
is continually increasing**

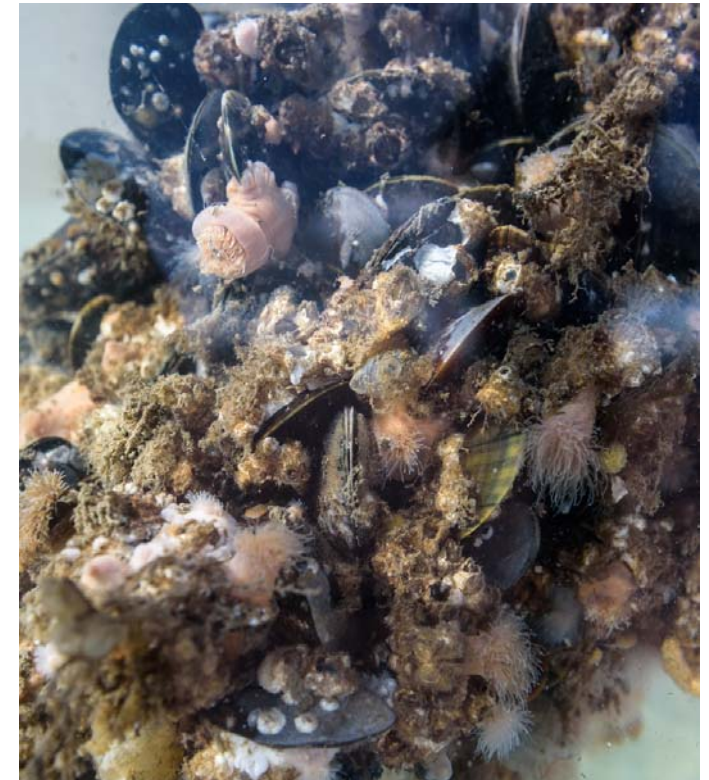
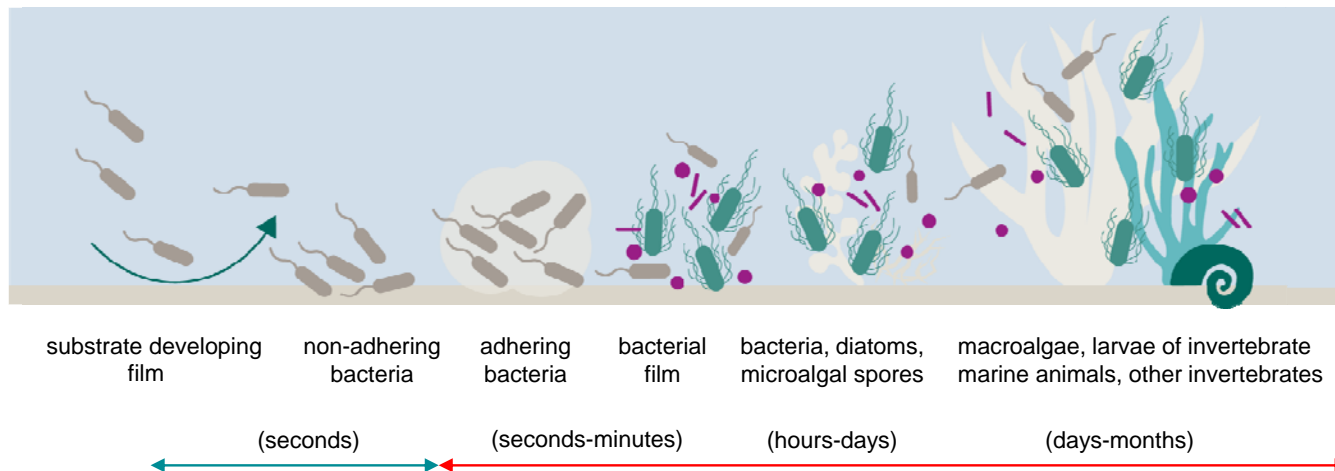


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# Biofouling: small adversaries for big ships

- Proteins, carbohydrates, and micronutrients become attached to the ship
- Here they serve as food for other microorganisms
- Biofilms provide a habitat for over 400 species



Source: Matériaux & Techniques 93, 27-41 (2005) Hors Série: Biofilms et altérations des matériaux : de l'analyse du phénomène aux stratégies de prévention, D. Haras

## Negative impact on energy efficiency and climate footprint

- Biofouling increases resistance due to friction
- 30 percent increase in fuel consumption
- Increasing CO<sub>2</sub> emissions
- Shorter maintenance intervals, limited maneuverability, faster corrosion
- Introduction of invasive species

### IMPACT OF BIOFOULING ON THE GLOBAL MERCHANT FLEET

	Additional drive power [%]	Potential fuel savings [mill. of metric tons]	Additional costs [approx. billions of \$]	Δ CO <sub>2</sub> emissions [mill. of metric tons]
<b>New coating</b>	0	0	0	0
<b>Major slime layer</b>	19	92	46	279
<b>Slight to no hard fouling</b>	33	160	80	486
<b>Moderate hard fouling</b>	52	253	127	768
<b>Major hard fouling</b>	84	408	204	1,238

Source: Advances in Marine Antifouling Coatings and Technologies, Claire Hellio & Diego Yebra, 1<sup>st</sup> Edition (2009)

# Vision: efficient, environmentally friendly antifouling paints

## In the past

- Heavy metals such as lead and later tributyltin hydride (TBT)
- Ban on biocides based on tin-, arsenic- and mercury bonds



## Today

- Cuprous oxide is the material of choice
- The search for effective alternatives



## Vision

- Antifouling paints that are more efficient and better for the environment
- New hybrid systems function without the use of biocides



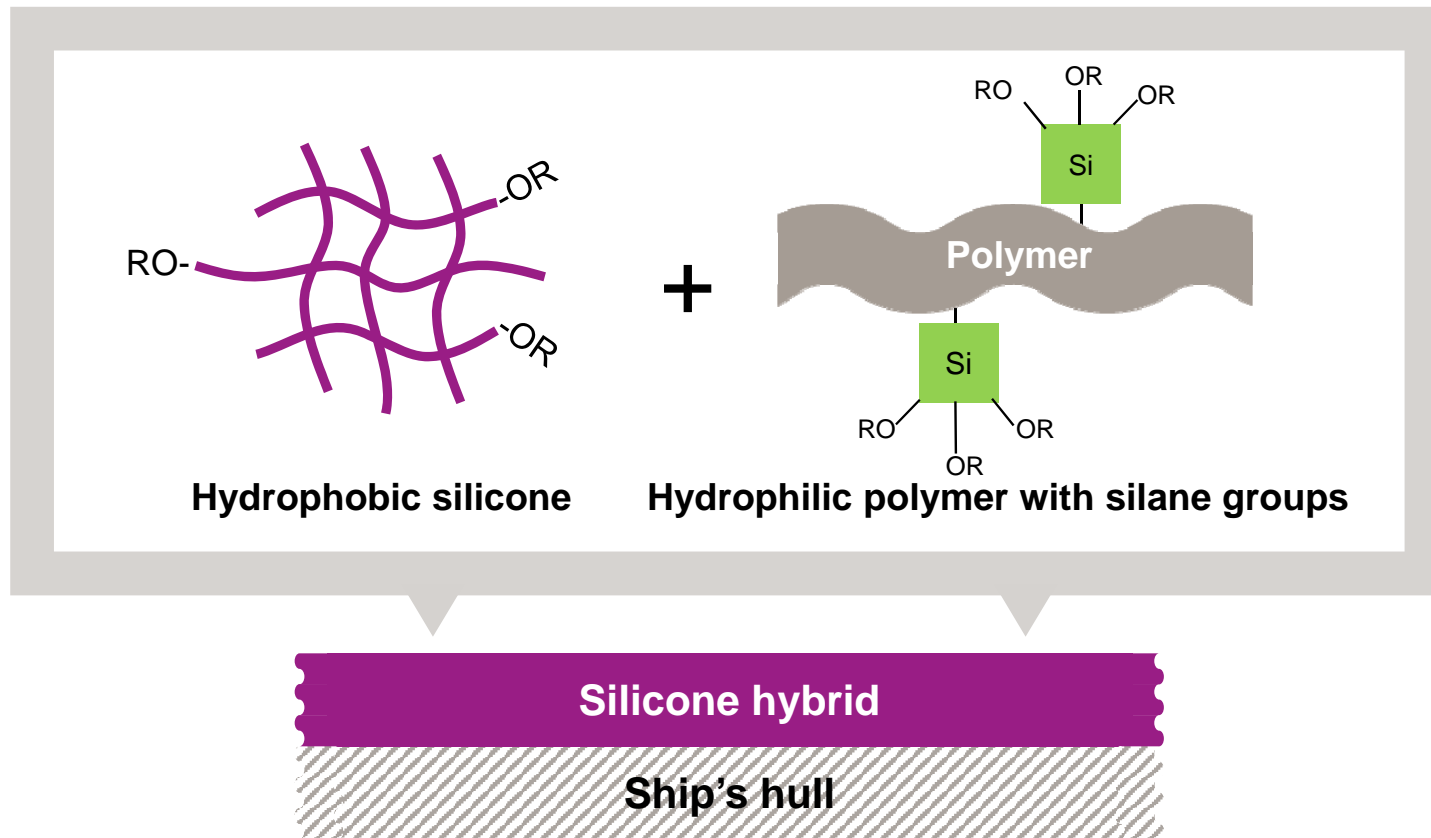
# The “S<sup>3</sup>” Competence Center is working on unresolved questions in the paints and coatings industry

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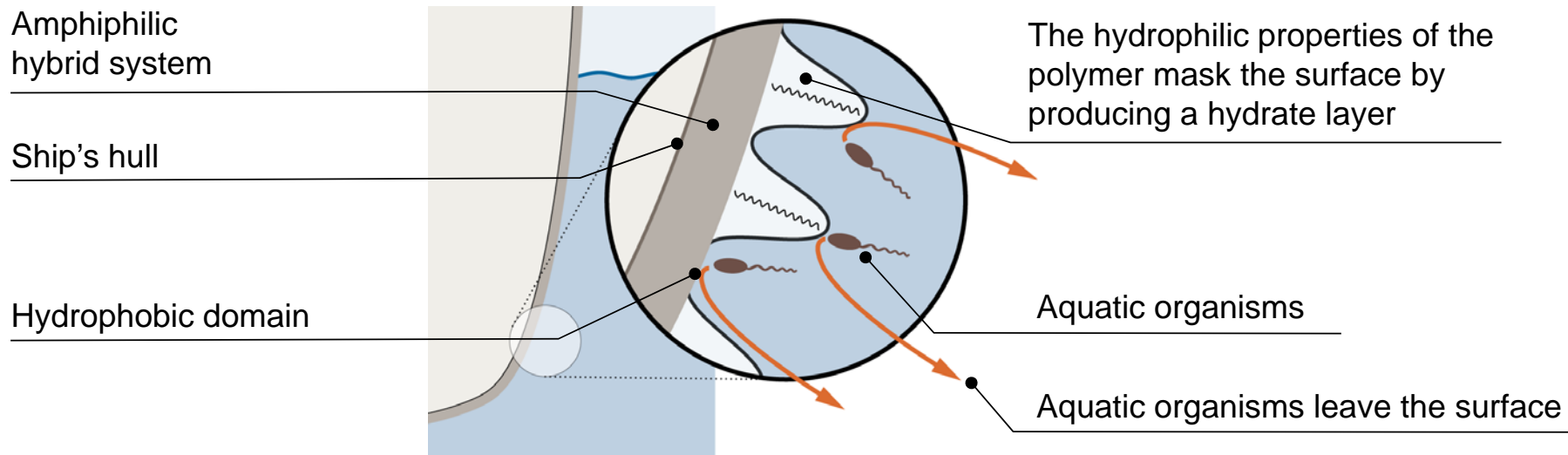
- Evonik is bundling expertise in its newly established “Smart Surface Solutions (S<sup>3</sup>)” Competence Center
- Scientists currently work at sites in Essen and Singapore
- S<sup>3</sup> combines expertise in the fields of coatings and specialty polymers in order to selectively improve surface properties
- Quicker access to technologies and production capacities within the company



## Solution: a new hybrid system acts as a cloak of invisibility for the hull



## Antifouling protection combined with an easy-to-clean surface

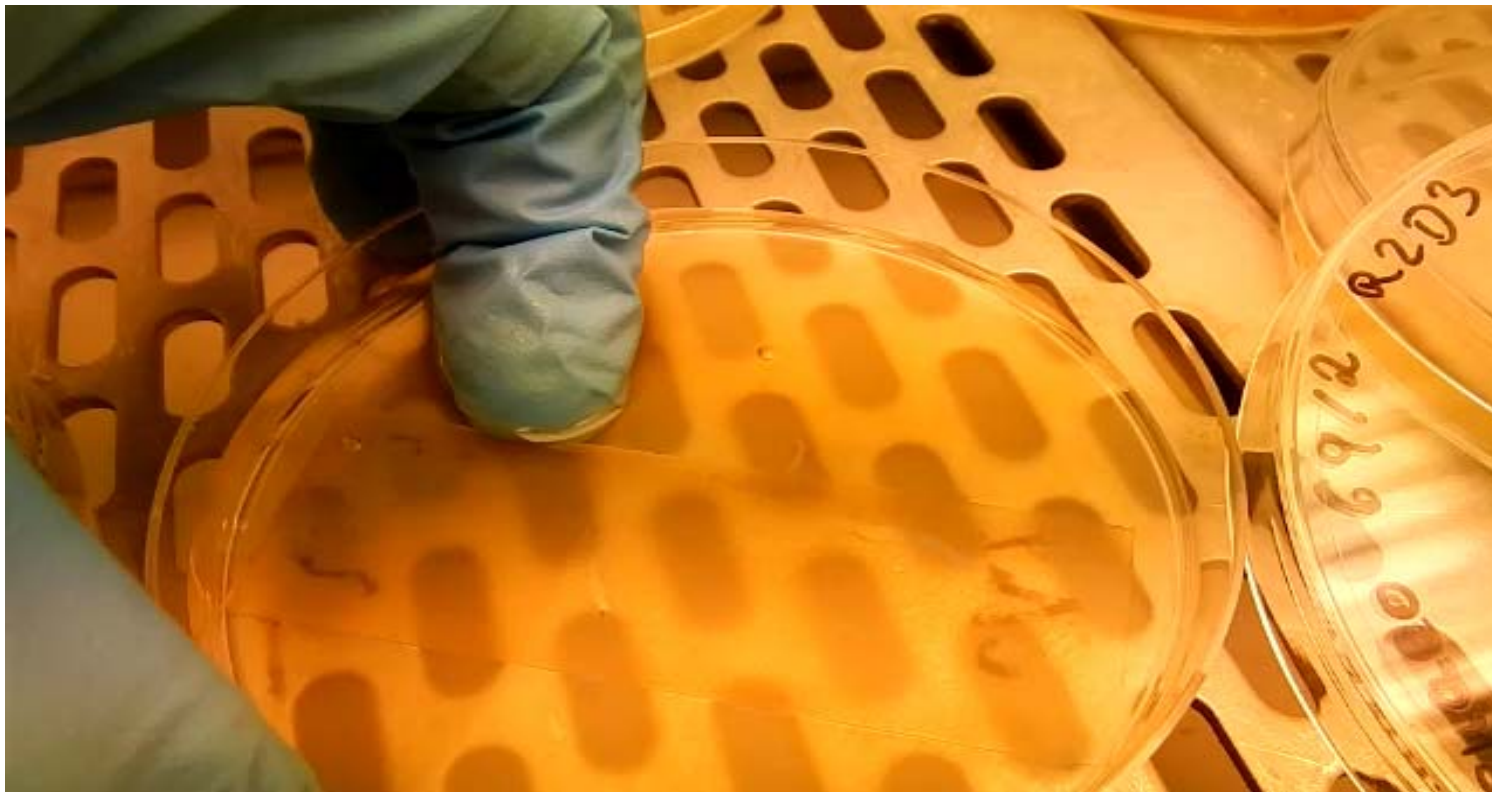


- Microorganisms cannot distinguish the surface from seawater: no build-up takes place
- Surface adhesion is largely prevented: the surface is easy to clean



## Initial laboratory tests confirm antifouling effect

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## Powerful antifouling effect demonstrated

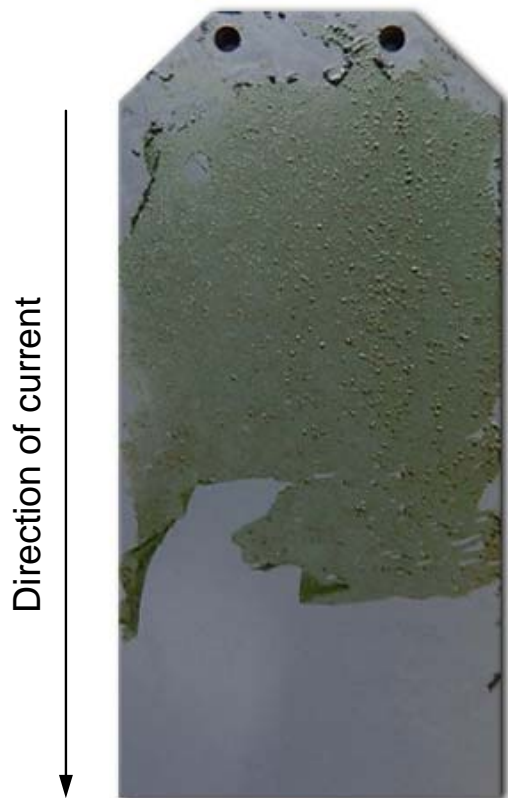
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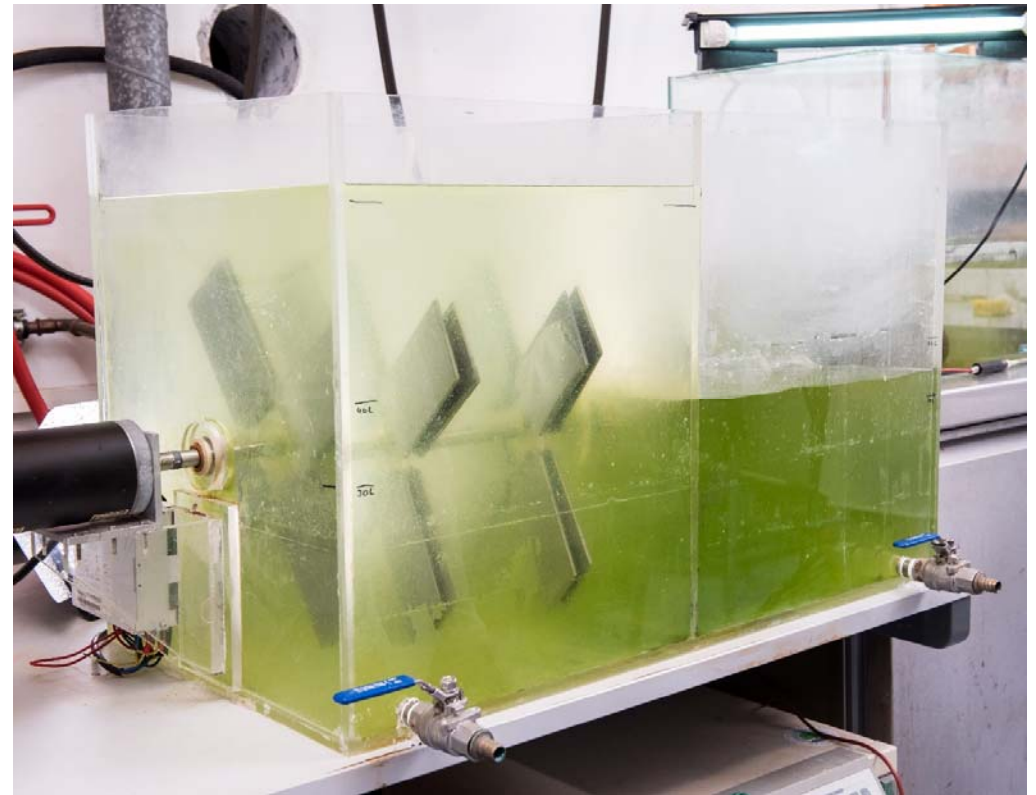
Biofouling evident on  
uncoated surface

Coating with hybrid system

## New test methods confirm system efficacy



Incubated at 21°C,  
ventilated,  
14/10 hours alternating  
between light/dark,  
35 days of growth /  
7 days of rotation



## Aquarium seawater tests show outstanding efficiency

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Observation of test panels following a cycle of 35 days of growth and 7 days of rotation (1-28 knots)

**New hybrid system**



**No hybrid system**





## Successful tests under real-life conditions in the North Sea

- Laboratory studies of the coatings followed by tests under real-life conditions
- Test plates with sample coatings placed in the North Sea
- Researchers use the natural biofouling growth period
- Growth pressure is greatest from March to October



# Outlook

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Novel hybrid binders show positive antifouling properties and an easy-to-clean effect

Optimization of surface properties and developments in collaboration with leading paints and coatings manufacturers

Intensified field testing

Novel coatings to be established from 2020

Research results utilized in other S<sup>3</sup> subprojects

