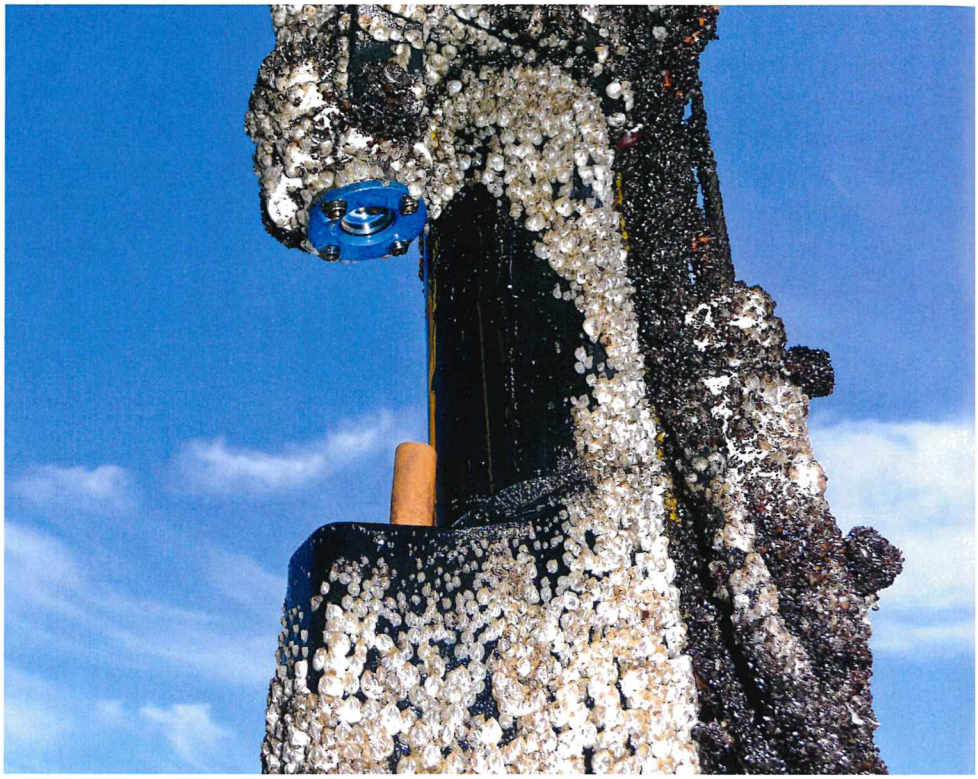
UV light tackles problem

Innovative antifouling system from IOW now ready for serial production

The adhesion and accumulation of living organisms – so-called biofouling – is a major problem for any technical equipment that has to remain operational underwater for long periods of time. Crusts of mussels and barnacles usually cause mechanical problems, but even thin biofilms of algae and bacteria can damage sensitive surfaces and measuring equipment as well as interfere seriously with measurements. Following around three years of development, an antifouling device designed at the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Germany, has now been licensed for commercial production. For the first time, the new system uses lens optics to focus the UV light of energy-efficient LEDs and thus keeps irradiated surfaces permanently free of fouling.

The new antifouling UV spotlight was developed for the continuous deployment on three autonomous measuring stations, which the IOW operates in the middle of the Baltic Sea on behalf of Germany's Federal Maritime and Hydrographic Agency (BSH) for monitoring the marine environment. Underwater sensors continuously register temperature, salt and oxygen content, currents and the development of phytoplankton by means of chlorophyll a fluorescence measurement.



Lasting antifouling effect after 10 weeks and more. The new antifouling UV spotlight (blue, top) was able to protect an underwater probe (orange, bottom) permanently and precisely from barnacle colonisation. Photo: IOW/M. Sommer

"A decisive factor for ensuring a consistently high quality of underwater long-term measurements is the efficient control of biofouling," says Robert Mars. The IOW instrumentation expert is in charge of the technical operation and support of the three Baltic Sea stations and is the inventor of the new antifouling UV spotlight.

"Organisms that colonise probes have a considerable effect on the sensory equipment, for example by hindering the flow of oncoming water, altering the measuring environment in the close vicinity of the probes, weakening their sensitivity and much more. For example, without antifouling, it takes only two to four weeks

IOW engineer Robert Mars developed the LED-based UV antifouling system and carried out intensive field testing in the middle of the Baltic Sea. Photo: IOW/M. Sommer

atic underwater growth

– depending on the season – until algae growth massively falsifies the measurement of chlorophyll a fluorescence," Mars explains.

However, since the measuring stations can be serviced by ship only five or six times a year, chemical antifouling or quite inefficient mechanical aids have so far been necessary, says Mars. "Especially since the tributyltin compounds (TBT), a highly toxic antifouling agent, were banned EU-wide in 2008, fouling has become a chronic problem in underwater measurement technology," adds the IOW engineer.

A non-toxic alternative is UV-C light with a wavelength of 200-280 nanometres. "This has already been used for disinfection for quite some time – also underwater. But only in recent years, high-performance UV-C light-emitting diodes (LEDs) have been available that, compared to traditional UV mercury vapour lamps, have exactly the properties we need for the use under the extreme conditions at the Baltic Sea measuring stations," says Mars about the initial starting point for his innovation. "The UV-C LEDs are compact and robust, have a very long life and a narrow emission wavelength band exactly in the desired range, so that no energy is unnecessarily wasted on other wavelengths. On the whole, the LEDs are incredibly energy efficient, which is essential for long-term operation that depends on battery power."

From spring 2017 onwards, Mars, together with colleagues from the IOW instrumentation team and the institute's fine mechanics workshop, developed and tested various prototypes of a LED-based UV antifouling system. At the end of the development, which was financed by the BSH in the final implementation phase, the result was a handy device with a robust titanium casing and a plastic mount from the 3D printer, which can be produced quickly and is easily adaptable to different installation conditions. Most importantly, however, for the first time quartz glass lenses focus the UV light to counteract underwater light scattering and efficiently direct the radiation exactly to the target area where it is needed. Both, point and area emitters, can be realised.

The anti-fouling UV spotlight (top left) pictured before long-term deployment, with a titanium housing, a plastic holder produced from the 3D printer and a lens system for focusing the LED UV radiation. Photo: IOW/R. Mars

The IOW's new antifouling UV spotlight has already been successfully in use at all three Baltic Sea measuring stations since June 2019. "It has passed the intensive testing with distinction," reports Mars. "All target areas could be kept completely and permanently free of fouling by irradiation from a distance of up to one metre. The UV exposed sensors, in particular the interference-prone chlorophyll fluorimeter, now consistently deliver very good data and the casing successfully defies the harsh field conditions in the middle of the Baltic Sea."

A patent is pending for the spotlight with its innovative first time use of the lens optics, which are key to its powerful antifouling effect. Mars is in no doubt that the lenses make the system vastly more efficient than any other commercial products so far available on the market for comparable applications.

The IOW engineer assumes that there is a great demand for such a handy and flexible antifouling device, especially in marine research.

"But one can also imagine many other areas of application, for example in aquaculture, where the long-term use of underwater sensor technology also plays a major role," he adds.

In order to make the IOW's antifouling UV spotlight accessible to a wide range of users, it has been licensed for serial production by the German-Chilean company Mariscope-Meerestechnik since February 2020 and can be pre-ordered as of now.

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