CASE STUDY:

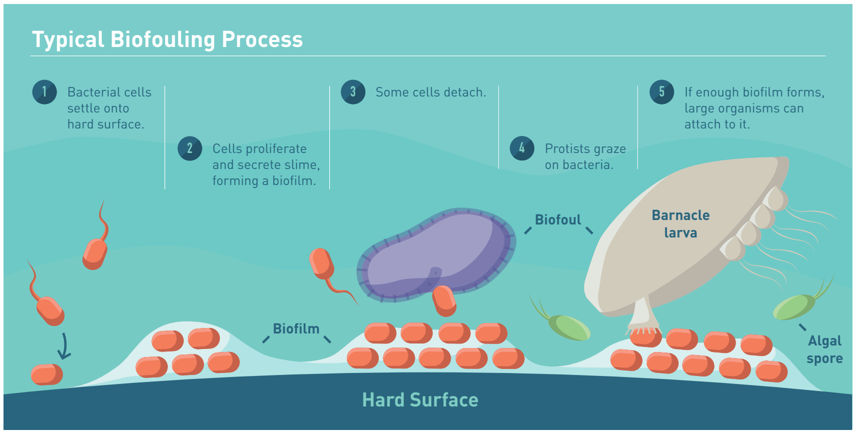
Idronaut

Idronaut, is a leader in the design, manufacturing and support of high-performance and innovative oceanographic sensors and instrumentation.

CHALLENGE

CTD (conductivity, temperature and depth) sensors are used to calculate salinity, density, sound velocity and other parameters in the ocean. CTD sensors are prone to biofouling (an accumulation of unwanted biological matter on surfaces) (Figure 1), which can cause drift, loss of sensitivity, and variation in response time. Although the time for biofouling impact varies, the problem must be addressed as long as measurements longer than a week are involved. In ocean monitoring, biofouling has long been considered as a limiting factor to the length of deployment for underwater instruments and sensors. The Alliance for Costal Technologies has estimated that maintenance costs due to biofouling can consume as much as 50% of operational budgets.

FIGURE 1



"THE HIGH LIGHT OUTPUT OF OPTAN UVC LEDS ENABLES US TO PREVENT BIOFILM FORMATION AND CONTROL BIOFOULING. THE LONG LIFETIME OF OPTAN UVC LEDS ALLOWS US TO EXTEND THE DURATION OF DEPLOYMENT."

Flavio Graziottin,
Idronaut Sr. L.

The most popular method for biofouling control, a biocide called Tributyl tin (TBT), has been banned due to environmental regulations and so most instruments currently use wipers and scrapers for prevention. While these mechanical devices are environmentally friendly, the wipers themselves are prone to fouling, have a high failure rate and relatively high power consumption. Other methods of protection such as copper shutters and chlorine generation are also used but they too suffer from performance limitations.

> **"INTEGRATING UVC LEDS INTO THESE INSTRUMENTS FOR BIOFOULING CONTROL IS AN EMERGING TREND THAT WILL BECOME ONE OF THE MAINSTAYS OF THE INDUSTRY IN THE COMING YEARS."**
>
> ***Flavio Graziottin, Idronaut Sr. L.***

Deep ultraviolet (UVC) irradiation offers a better solution as it is non-contact, non-chemical, and can be used across a range of instruments. Radiation in the UVC range of 250 nm -280 nm can be used to control biofouling by preventing biofilm formation. Light in these wavelengths deactivates bacteria, viruses, and other microbes by destroying the genetic information inside the DNA. By deactivating the microorganism, UV light prevents the formation of a biofilm, thereby preventing the later phases of biofouling where larger organisms attach to the instrument and render the instrument inoperable.

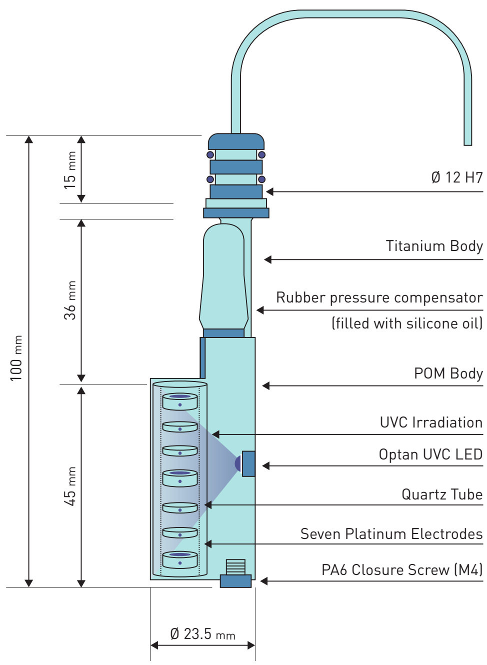
Although the potential of UV radiation for biofouling control has been known for some time, traditional UV lamps containing mercury are not a feasible option in many aquatic settings due to their bulk, fragility, high power consumption, and the toxic nature of mercury. These lamps are also difficult to start in cold environments.

LEDs that emit UVC light offer a more suitable solution that overcomes the limitations of mercury lamps. They consume less power, have a smaller footprint for more design flexibility, and high brightness in the necessary germicidal wavelengths. However, the earliest commercialized UVC LEDs based on sapphire substrates had poor lifetime, which meant relatively frequent replacement—negating the benefits around increasing deployment timeframes.

SOLUTION

The availability of high light output, long lifetime UVC LEDs from Crystal IS has enabled designers to use UVC LEDs for biofouling control in ocean instruments, including CTD sensors. Idronaut evaluated the Optan SMD LEDs for biofouling control in their conductivity sensor installed on the OCEAN SEVEN 3xx series of CTDs. The Optan SMD LED prevents biofouling in the CTD sensor by disinfecting the small volume of water around the sensor area to prevent microbe growth.

FIGURE 2



Schematic of the Idronaut conductivity sensor incorporating a Crystal IS Optan LED for biofouling control.

The amount of UVC radiation needed to prevent biofilm is referred to as the required UV dose. The effective UV dose is comprised of two factors—the intensity of the light and the length of exposure time. Idronaut used the relationship between these two parameters to develop an effective system that prevents bacterial growth while optimizing the duty cycle for the UV irradiation. By operating in a duty cycle mode, the LED is periodically turned on to deactivate DNA and then turned off to minimize power consumption. Optimization of the duty cycle is required since cell division of colonized bacteria and colonization of fouling organisms happens during the intervals between UV radiation exposures.

By controlling the biofilm growth, Idronaut is now able to extend the duration of in situ deployment of its CTD sensors in marine environments to six or twelve months depending on the deployment site environmental conditions.

Crystal IS ADVANTAGE

LEDs respond instantaneously, are environmentally friendly and offer design freedom over traditional light sources. In addition, Crystal IS deep UV LEDs deliver:

>Long lifetime which extends replacement cycle

>High light output which is ideal for biofouling protection for sensors of varying sensors and in harsh environments

>Small footprint which enables easy integration with existing sensors

Crystal IS™
High Performance UVC LEDs

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