Title: Optimized and high efficiency biofouling protection for oceanographic optical devices

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Oceans environmental monitoring and seafloor exploitation need *in situ* sensors in various locations and on various carriers in order to initiate and to calibrate environmental models or to operate underwater industrial process supervision. From coastal to deep sea, one of the main bottlenecks to perform such task is to prevent the transducing interfaces of the sensors from biofouling development. The major problem is to provide real-time reliable measurements without requiring too frequent maintenance, therefore too expensive or even impossible to achieve for systems in deep environment or far away from the coast. Without effective protection against biofouling this goal is unachievable.
Marine biofouling, in the spring, can grow and colonize a system in a week. This colonization causes a drift of physico-chemical sensors thus provide measurements outside tolerances that become unusable. Imaging systems, cameras and projectors are even disrupted by biofouling. Images become blurred or noisy, projectors lose their light intensity.
Many techniques are actually available off the shelf to protect sensors from biofouling development, for example, passive technics like copper coatings, hydrophobic coatings or bio-mimetic surfaces, and active technics mainly based on wipers, UV irradiations, bleach, and biocide generation by localised seawater electrolysis. These technics have been referenced in publications these last years.

For optical sensors, Ifremer has developed a very efficient biofouling protection. This technic offers a high level of robustness (no moving parts), a high level of protection efficiency (the whole optical window is protected) and consumes very low energy. It has the advantage to be an active technics that then can be turned ON and OFF in order to arrange free biocide generation period.

This specific biofouling protection technic has been coupled to an ALVIM biofilm sensor in order to apply the active biofouling protection only when fouling pressure is indeed sensed by the biofilm sensor. This allow to optimized at it's maximum the efficiency in term of energy needed and in term of biocide free period to allow proper measurements or usage of the optical device. The results of such arrangement will be presented in this paper.

The biofouling protection technic is based on the coating of the optical window by a "transparent" conductive layer. This robust transparent conductive layer is polarised in order to generate a very low quantity of hypochlorous acid on the whole surface of the optical port. This technic has been designed at a laboratory stage (Technological Readiness Level 4) many years ago. Then, the coating has been tested in natural seawater to validate it's aging and it's biofouling protection efficiency on Chl-a fluorometers. The coating remains stable in seawater for up to 3 years.

Under the EU Nexos project, the biofouling protection of 3 Chl-a fluorometers is a 100% success and has achieved 2 years duration in natural marine environment. These recent results allow using this technic for operational deployments of optical sensors and imaging systems, considering now that the development reached a Technological Readiness Level equal to 7. An example of such deployment will be explained in this paper.