Biocide-free Ecofriendly Antifouling Marine Coatings using Bottlebrush Polymers

Chiaki Yoshikawa[1,2*]

[1] *Research Center for Macromolecules and Biomaterials, National Institute for Materials Science (NIMS), 1-2-1 Sengen, Tsukuba, Ibaraki 305-0047, Japan*

[2] *Graduate School of Life Science, Hokkaido University, Kita 10, Nishi 8, Sapporo 060-0808, Japan*

**Correspondence: YOSHIKAWA.Chiaki@nims.go.jp (C. YOSHIKAWA)*

Abstract.

Major antifouling marine paints on the market contain cuprous oxide as a biocide. Although the products are effective at preventing biofouling, the possibility cannot be denied that long-term leaching and the accumulation of cuprous oxide in the ocean may destroy the marine environment and ecosystems, similar to tributyl tin biocides. Therefore, many efforts have been made to develop biocide-free, non-releasing antifouling coating technologies.

In this work, we developed a next-generation, biocide-free marine antifouling coating technology. Our approach merged two uniquely different polymers from our previous innovations. First, we synthesized well-defined 2-hydroxypropyl acrylamide (HPA) based bottlebrush polymers with concentrated polymer brush (CPB) structures, which exhibit excellent bioinertness and low-friction property. Secondly, we synthesized photoreactive linear copolymers of 2-hydroxypropyl acrylamide (HPA) and *N*-benzophenone acrylamide (BPA) which rapidly crosslinks upon exposure to UV lights for 3 min or sunlight for just 30 minutes. By simply mixing these two types of polymers and coating onto polymeric substrates, we have developed a scalable method for achieving effective antifouling properties in one step on a broad range of polymer substrates.

The resistance of coatings against hydrolysis in seawater was demonstrated in accelerated degradation experiments at 80 °C, and the coating thickness was stable after 24 h heating. The coating was also confirmed to be stable for 3 months dipping in sea water at room temperature. The optimized coatings prevented Cypris larvae attachment for up to 9 days and prevented the settling of marine organisms in the sea for up to 2.5 months. Due to the ease of application, long-term durability and effective antifouling property, our bottlebrush coating technology is expected to be exploited in biocide-free marine paints, realizing energy-saving and low environment loads. The details will be discussed.

References

1. Yoshikawa, C**.;** Takagi, R.; Nakaji-Hirabayashi, T.; Ochi, T.; Kawamura, Y.; Thissen, H. *ACS Applied Mate. Inter*. **2022,** 14, 32497-32509.

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